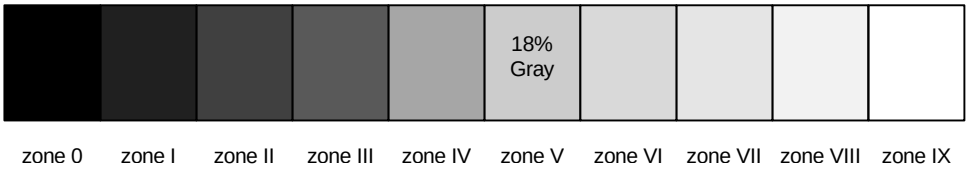
The Zone System is an exposure system which was conceived by Ansel Adams in which the photographer assigns tonal values to the objects within his frame. And then controls those tonal values through careful exposure control.

Minor White took the Zone System a step further when he developed his **Density Parameter System**, in which he charted the density of a negative according to the duration of time in development. From the marriage of these two image control practices, the Zone system as we know it today was born. The modern practice of the Zone System employs careful exposure control combined with image specific negative processing and custom printing to exercise maximum control over the final resulting image.

Still photography allows for far greater image control than does motion picture photography because each individual medium to large format negative can be treated individually according to the intent of the photographer. This is a luxury which is not shared by the motion picture photographer.

The basic principle of assigning tonal values however is of great value to the cinematographer.



You can see from this chart that zone V falls on middle gray. The other zones represent different densities ranging from black to white.

zone 0 = Absolute Black with no detail or texture
zone I = Very Dark Gray, still without detail or texture
zone II = Dark Gray with only a hint of detail or texture
zone III = Dark, but the first zone with substantial information--shadow area that contains detail and texture
zone IV = Darker than middle gray, but with an increasing amount of detail and texture
zone V = Middle Gray or 18% gray.
zone VI = light to medium gray
zone VII = light gray, similar to sand that is side lit with full texture
zone VIII = very light gray, the last zone to contain detail and texture
zone IX = white area that contains no detail or texture

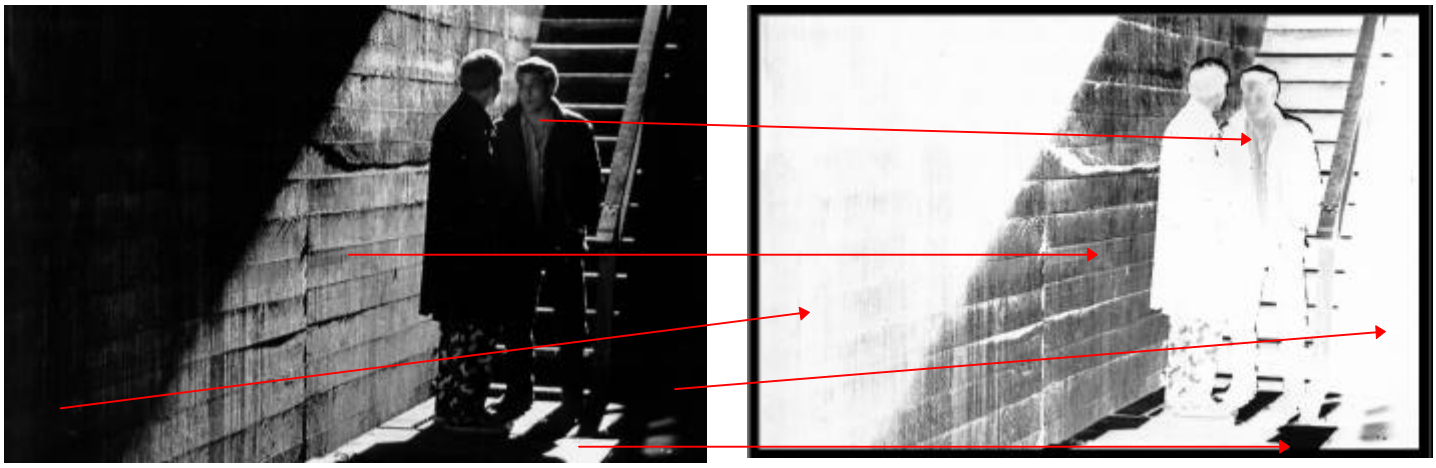
Reflected light meters (spot meters) are frequently used when assigning specific tonal values as they allow for reflected light measurements of specific areas within the frame.

Once you understand the concept of assigning tonal values to objects and surfaces within your frame based on the amount of light reflecting off those objects and surfaces, and you understand the exposure latitude of the film stock you are shooting, you can gain maximum control of the image you are creating.

DENSITY

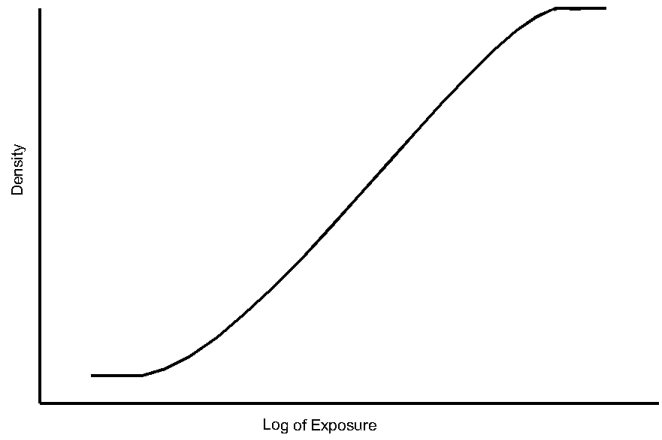
Negative emulsions react to light in such a way that the light areas of a scene are recorded as dark and the dark areas are recorded as light.

As exposure increases, the density of the corresponding portion of the negative increases. This appears as a dark or even black area on the negative. When the negative is printed onto a print stock, the more dense area of the negative blocks light from passing and renders the positive image lighter in the area which was lighter in the original scene.



Looking at this photograph and its negative, we can see how the black areas appear white on the negative, the gray areas appear gray on the negative and the light areas appear dark on the negative.

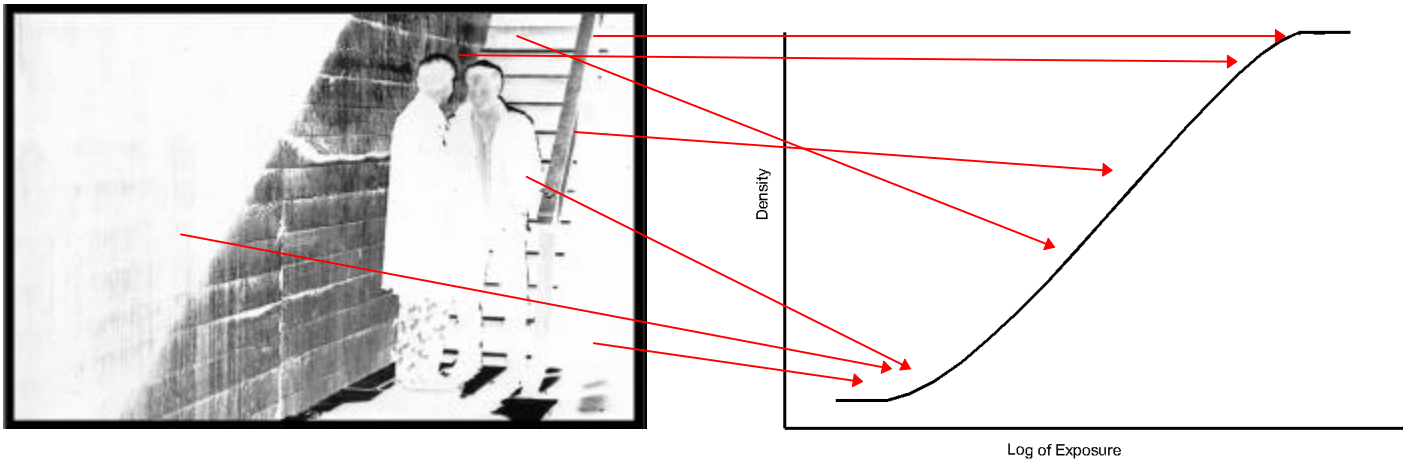
How then does photographic emulsion react to light? For every photographic emulsion there is a characteristic curve. The characteristic curve is a graphical representation of the way in which the emulsion will react to exposure to light. This curve is known by three names: 1) The characteristic curve, 2) the D log E Curve, so named because the graph demonstrates that the density of the negative is linked in a relationship to the logarithm of the exposure, and 3) The H&D Curve, named after Hurter and Driffeld, who first identified and plotted it.



The curve demonstrates that as the log E (exposure) increases, so too does the resulting D (density) of the negative.

But what is most interesting is that the increase is not linear as one might expect. It is indeed a curve, most notably at the two ends.

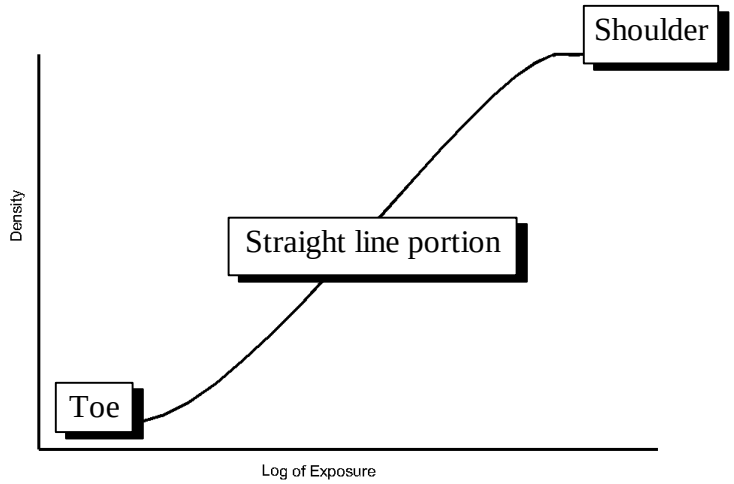
This is the fingerprint for an emulsion. It is the way each emulsion reacts to light that gives it its unique quality.



From this representation we can see that the areas of the negative that have very low density (light) have also received very little exposure and so will be rendered as dark in the positive image and the areas that have a higher density (dark) have received more exposure in the negative and will be rendered lighter in the positive image.

It is impractical to work with and plot the curve for an emulsion and a specific scene on set while working. But a thorough understanding of each emulsion's characteristics gives the cinematographer the ability to predict with incredible accuracy the results of his/her efforts. Put another way, understanding the characteristic curve is the first step to gaining control over the images you create.

Anatomy of the characteristic curve



As you can see from the above illustration, the curve does not begin at the intersection of density and exposure (the zero point). This is because every emulsion has intrinsic to its composition a base fog level. The base fog level shows that there is some density even at zero exposure. As the exposure increases, at first the density increases only slightly, it is not increasing in direct proportion to the exposure increase. This is the "Toe" of the curve. This reveals that at the toe end of the scale, there is not a directly proportional relationship between exposure and density.

As we enter the straight line portion of the curve, we can see that there is a more directly proportional relationship between exposure and density. This relationship of exposure to density

is called “gamma” The “gamma” is essentially the characteristic contrast which any film stock exhibits. In other words, if an object is twice as bright as another object, and if the density in that portion of the negative is twice as dense as the other portion, then the film is exhibiting a gamma of 1:1 or a direct and constant relationship between exposure and density.

Near the other end of the film’s ability to render any detail lies the shoulder portion of the curve. Again we can see that the shoulder flattens out much as the toe. This indicates that in the shoulder, as exposure increases, the density no longer shares its directly proportional relationship, until the point when an increase in exposure is beyond the emulsions ability to render an image and everything beyond that point appears white, with no detail.

Practical Shooting

When a cinematographer selects an exposure, what he or she is doing is effectively deciding which aperture to use at a given duration ($^{\text{shutter angle}}/_{360} \times {}^{1}/_{\text{frames per second}}$), taking into consideration the photosensitivity (film speed) of the emulsion used so that light of a specified intensity will render an 18% gray card normally *(*even if the light he or she is using is not of the intensity specified)*.

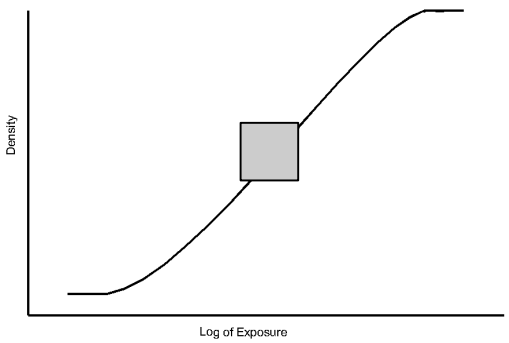
In most instances, cinematographers shoot at the normal frame rate of 24 fps (in the US) and with a predetermined shutter angle which remains constant except when special circumstances dictate that the frame rate or shutter angle be adjusted for a specific effect. Because of this, cinematographers mostly control exposure by selecting an aperture. This aperture or T stop is called “key” or the “key stop”. When lighting, the light which provides the necessary amount of illumination to expose the film at “key” is referred to as the key light. In other words, the **key light** is the light by which one sets the exposure.

Here’s where it can get a bit tricky. When shooting film, it is <u>not</u> always necessary to maintain lighting levels at key. The key level is simply the level of illumination that <u>would</u> render an 18% gray card normally at the given aperture, duration and film speed. If, however, the intent is to create a dark and mysterious scene, it is conceivable that nowhere in frame will there be a level of illumination that is up to key. Similarly, it is also possible that the bulk of the scene will fall well below key while some highlights coming from sources such as practical lamps in frame will be much brighter than key, with nothing really equaling key.

What’s important to understand is that it is <u>not</u> necessary to always light to key. Remember, even though nothing in frame is lit to key, the aperture you select is still the key stop—because <u>if</u> the light was of the right intensity, that stop <u>would</u> render a gray card normally.

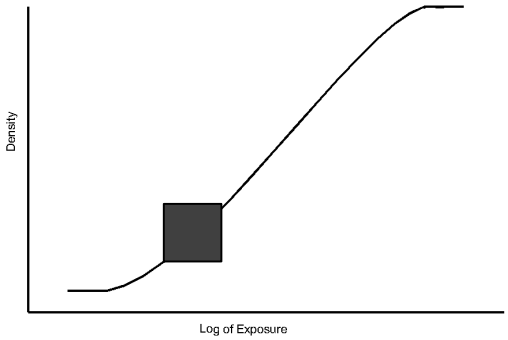
When we measure incident light and calculate an exposure, what we are effectively doing is deciding where on the characteristic curve we will place middle gray.

A “normal” exposure will position middle gray in about the middle of the straight line portion of the curve.



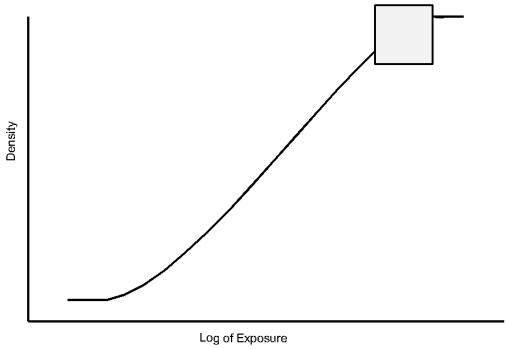
However, if we decide to reduce the exposure by selecting a smaller aperture *(larger number)*, so that the image is mostly dark, we have effectively decided to render a gray card in or near the toe portion of the curve.

In so doing we have now rendered the 18% gray card significantly darker in the print.



Similarly, if we decide to increase the exposure by selecting a larger aperture *(smaller number),* we will in effect render the gray card brighter than middle gray and in so doing move it up the curve into the shoulder portion.

Looking at it in this way helps us to visualize the degree of exposure latitude we can expect.



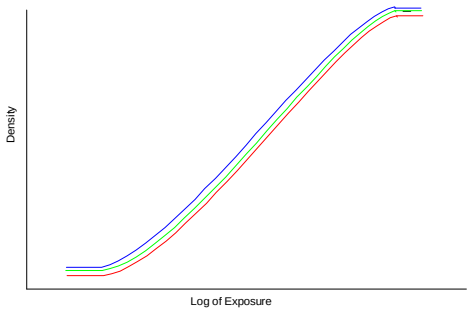
The same holds true when calculating exposure based on reflected light readings, though it is important to remember what the measurement given by a reflected light meter really means. Since it suggests the exposure given all the variables that will render the subject metered as 18% gray, it is crucial that the cinematographer evaluates the content of the frame and assign negative densities so that the resulting positive image will reflect his or her artistic intentions.

When we make choices in exposure, choosing to light one area of the frame and to keep another area in shadow, placing highlights on certain elements and bringing out the mid-tones in others, we are making choices which affect the resulting density of the overall negative. This in turn affects the positive image which we will print from the negative.

It is important to remember when calculating your exposure that you are concerned with the total tonal range (range of levels of illumination) within a shot. Selecting an exposure becomes a matter of determining where in terms of density you, as the cinematographer want each of the brightness levels to fall. You must then select the exposure which will render the desired results.

(Keep in mind that we are only discussing negative emulsions. Reversal films are very different.)

While we have not yet discussed color emulsions. Color film stocks employ multiple layers, each to record a different portion of the visible portion of the electromagnetic spectrum (light). Each layer will exhibit its own characteristic curve for that portion of the spectrum.



Exposure Latitude

Exposure latitude is the tonal range which a film stock can reproduce with acceptable results. In other words: given a normal exposure, how bright can the highlights become before losing all detail and how dark can the shadows become before losing all detail? Knowing these boundaries will enable you to maximize the range of tonal reproduction possible with any film stock in any given situation.

Another way to put this is: the exposure latitude is the range of the characteristic curve. Any exposure which renders a density equal to the base fog level is equivalent to zero exposure and considered beyond the latitude of the emulsion. And any exposure which is beyond the shoulder of the curve and so renders the subject as completely white with no apparent detail is also beyond the latitude of the emulsion.

Any exposure which renders densities that range from the toe through the straight portion of the curve to the shoulder are considered to be within the exposure latitude of the emulsion.

Of course, the degree to which a film stock's latitude should be maximized is dependant on the theme of the film and the intent of the film makers.

In some instances it may be more appropriate to minimize the tonal reproduction to feature a very limited range of tones (contrast range). This effect can be seen in scenes which feature a lot of fog, or a blizzard, or a dark location, with no visible light source.

The choice you make regarding tonal reproduction will depend on your pre-visualized plan for your particular film.