THE CHARACTERISTIC CURVE

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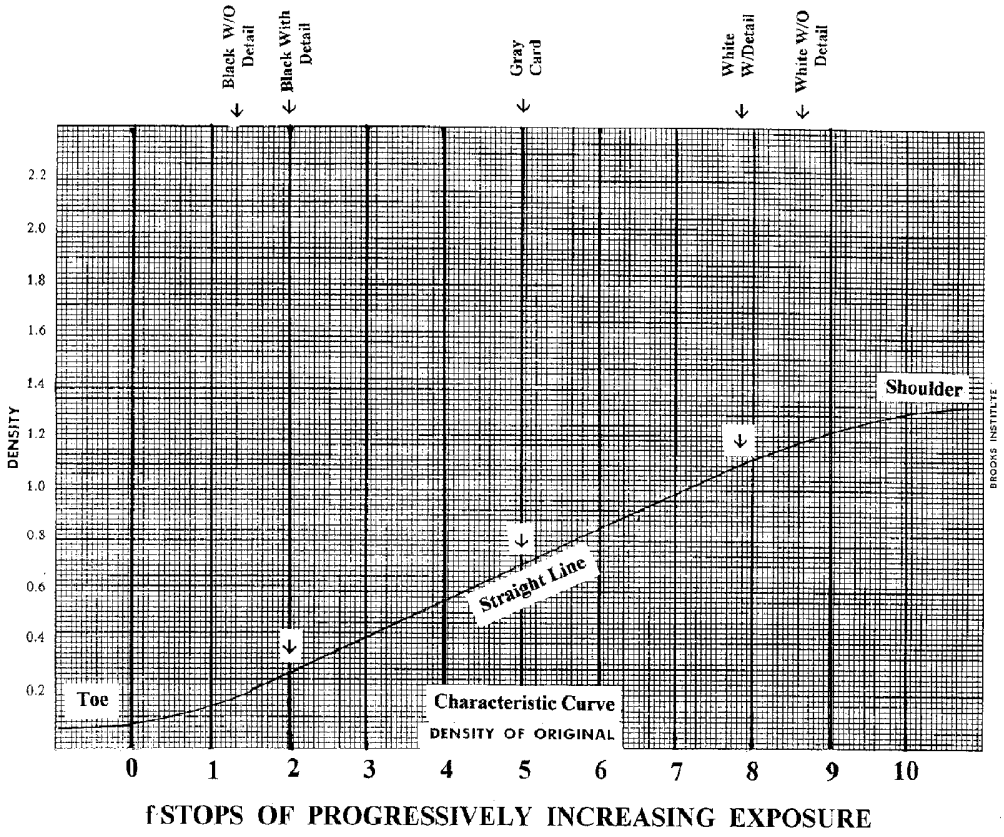

Normal Continuous Tone negative Average Gradient .49

All printable detail is carried in .80 of the straight line portion.

All printable tones are carried in 1.0 of the straight line portion.

This 1.00 of tonalities precisely matches the 1.0 Density Scale of World Standard #2 Paper

When film is given a series of progressively increasing exposures, the resulting densities when charted on a graph will appear as above. Notice that a considerable amount of exposure must be received before significant density increases occur, this is the *TOE* of the curve. Thereafter, exposure increases result in predictable and equal density increases, creating the so called, *STRAIGHT LINE* portion. When exposure increases beyond the straight line, there is progressively less increase in density creating the *SHOULDER* of the curve. Massive continuous increases in exposure beyond the shoulder of the curve may cause some density decrease producing partial reversal of the image, this is properly called *SOLARIZATION*. Herschel Effect and Clayden Effect both cause reduced density at the shoulder but for different reasons.

B/W Printing Papers

The world international standard #2 (Normal contrast) paper was established many decades ago as the paper with characteristics which would yield a pure white, a pure black, and the maximum number of visually separable tones between those extremes. A reasonably good result may be obtained from contrasts 1 and 3 but with some losses in middle tone discrimination. Contrasts above and below 1 through 3 are for truly emergency use since significant losses in detail and tonalities always obtain.

Important Definitions

BRIGHTNESS RANGE: The scale of tones in a scene, reported in density units, is called "Brightness Range".

DENSITY RANGE: The scale of tones in a negative, reported in density units, is called "Density Range".

DENSITY SCALE: The scale of tones which can be reproduced by a printing paper, reported in density units, is called "Density Scale".

Designation	World Standard D.S.	A.N.S.I. D.S.
5	#5 = .40	#5 = .60
4	#4 = .60	#4 = .80
3	#3 = .80	#3 = 1.00
2 World Standard	#2 = 1.00	#2 = 1.20
1 ANSI Standard #2	#1 = 1.20	#1 = 1.40
0	#0 =1.40	#0 = 1.60
00	#00 = 1.60	#00 = 1.80
000	#000 = 1.80	#000 = 2.00

Negative to Print Relationship

The exposure and development of a negative, when properly accomplished, should result in a total printing density range which matches the "Normal" printing paper, usually 1.00. This relationship determination goes back to the end of the 19th century. When most photographs were produced by contact printing, slightly different standards were used. When enlarging became the standard means of reproduction the current standards were adopted (approximately 1954).

The 1.00 Density Range to 1.00 Density Scale was selected by the ANSI predecessor ASA as the relationship that produced the greatest scale of tonality, yielding a pure black, a pure white, and the maximum of visually separable tones. Higher contrast papers would cause middle tone merging resulting in less scale while lower contrast papers would possibly create more middle tones but the reduced separation would make the differences harder to see.

It appears that the new ANSI standard is designed to conceal the fact that variable contrast papers cannot be made in contrasts much higher than D.S..60 (World Standard #4) and secondarily, films must be developed longer to match the lower contrast paper (higher Average Gradient) allowing a higher film speed to be claimed.

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Background Information

The characteristic curve, sometimes called the H&D curve (after Hurter and Driffield, the English investigators who in 1890 first published data on sensitometry) is a line graph clearly showing the effect of equal increases in exposure at any tested level of development. It does not take any great skill to infer the films characteristics from the curve. The characteristic curve is part of the quality control of photography. The following are important to understand quality control.

SENSITOMETRY: The science which treats of the reaction of photographic emulsions to exposure, development, and other procedures effecting changes in density, color, or contrast.
DENSITOMETRY: The science of the measurement of sensitometry's affect.
SENSITOMETER: Any device which exposes photographic emulsions in precise steps.
DENSITOMETER: Any device which reads or measures the density (light stopping or absorbing ability) of a sample, whether by reflection or transmission.

Due to the numerically high variations in light stopping ability, a special system was adopted to chart, graph, and describe these variations. Following is the source of the methodologies which we use.

TRANSMITTANCE OR TRANSPARENCY: Expressed as a percentage of the original light sources penetrating the sample. This can be a clumsy figure with many decimals and many zeros, lending itself to errors in transcribing and in calculating.

OPACITY: The reciprocal of the transparency. If $1/10^{th}$ of the light is transmitted, the opacity is 10. Due to the fact that the opacity of higher deposits of light stopping photographic deposits can be in the 1,000's or even in the 10,000's. These numbers tend to be difficult and clumsy to use.

DENSITY: The log of opacity, an easy progression to deal with and is an easy shorthand for extremely large or small numbers. This permits the construction of line graphs (characteristic curves) which exaggerate, graphically, the differences in such a way that we can know many things about the performance of a photographic emulsion at a glance.

Transmission %	Transmission Decimal	Opacity	Density
100%	1.00	1.00	0.00
10%	.10	10	1.00
1%	.01	100	2.00
.1%	.001	1,000	3.00
.01%	.0001	10,000	4.00
.001%	.00001	100,000	5.00