The VIDEC System

Precise Control for Superior Black and White Photography

Andrew C. Eads

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Dedication

This book is dedicated to the memory of my father, the late Dr. David K. Eads.

Acknowledgements

It has taken over 17 years to work out the principles of VIDEC, test the concepts, and refine this presentation. That it exists at all is due to the unfailing encouragement of my wife, Noreen.

Along the way I had indispensable help from Candace Devary who helped groom the text. Steve Lebel provided the perspective of an enthusiastic user and a critical eye for detail.

Mary Anne Lauby and Jim Yount who are constant friends, posing patiently for photographs as I tried to work out the bugs, laughing with me when my thermometer exploded in their kitchen, and lending me their darkroom when mine was but a table in the bathroom.

Tip of the hat to Michael Johnston, Joe White and S. Tinsley Preston at Preston Publications who had confidence in this work and were first to publish excerpts in PhotoTechniques Magazine.

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Introduction

The Gift

Carried on the wings of light is the gift of vision. Artists who use light's power to convey their feelings, involve themselves and their viewers in the complex realm of vision. Visual perceptions are often very different from the physical attributes of a scene. Yet, our perceptions are our personal reality.

While photographs have the power to convey a strong sense of reality, the camera records only a few of the physical attributes of the scene. More important, the camera records a scene in a way that is fundamentally different from the impression we receive from our eyes.

The scene before the camera, the captured image, and the interpreted image we create in the print are three worlds apart. To consciously make a photograph that transcends the ordinary, it is necessary for us to fully employ the inter-relationships between these worlds.

Some photographers make prints with crystalline highlights and shadows brimming with detail. Others emphasize graphic form and shape by way of strong blacks and whites. Yet others trace images of delicate beauty within a narrow palate. Two questions naturally arise. How does a photographer deliberately set out to interpret something seen? What is the craft that will enable the photographer's interpretation?

The Search

My search began at the age of 17. I came across the instruction manual for my dad's vintage GE light meter. Toward the back of the booklet was a brief and tantalizing description of the relationship between exposure, development, and density. It was illustrated with a simple graph.

Those few pages sparked my interest in the notion that the outcome of a photograph could be intentionally controlled. But there were still many unanswered questions. I wondered how the "relative exposure" numbers across the bottom of the graph related to the light in the scene, the meter reading and the f/stop and shutter speed on my camera. How did the density scale relate to the shadows and highlights in a print?

So I studied the Zone System, read Ansel Adams, Minor White, Phil Davis and others, attended a highly regarded photography school and made many photographs. Yet the fundamental understanding that would link the elements of the process into a unified whole eluded me.

I rarely made a truly excellent negative. It seemed to happen only when the sum of all my errors added up to "no net loss." Sometimes the opposite happened; the accumulation of errors added up to serious problems. Occasionally they added up to a loss so severe that the negative was not worth printing.

Surely, there had to be a means to fully control the photographic process using the wonderful meters, cameras, film and papers we now have available. With the help of many good friends, books, and a period of intense study, I worked out the principles of VIDEC.

As I applied VIDEC to my own photography, I began to enjoy consistent success; making negatives that were the expression of my intentions. I learned how liberating it is to be master of your craft. These principles have proven to be the key to producing negatives that are the best rendition of my vision. I trust it will do the same for you.

The Problem

If you have worked with black and white photography for very long, you know that changing the film development directly affects the effort it takes to print the resulting negatives. With some testing, trial and error, you learn which development scheme works best for certain subject conditions. You also learn which film speed works best.

But the world is full of subjects of differing contrasts and greatly differing light conditions. For example, if we observe the effect of sunlight on a subject at various times of the day, we will see luminous qualities ranging from subtle, under the soft diffuse light before dawn, to stark, under the hard-edge light of clear sky sun. However, to account for all the variations by trial-and-error testing would take an enormous amount of time, not to mention an unfailing memory to recall the vital bit when needed.

Compounding the problem is the adaptability of our visual sense. Whether the lighting ratio is 1 to 5 or 1 to 5,000, our eye (in combination with our brain) effortlessly gives us a satisfyingly full visual pallet of dark tones to light tones. Photographic materials by comparison do not automatically compensate for brightness differences.

So how can limited experience cope with all the possibilities? When you encounter a new and exciting photo opportunity, how can you know that you will get the image on film the way you envision it? How do you design a test that gives you meaningful results? How can you produce a negative with optimum printing properties every time? A system that accounts for the worlds of vision, capture and display is required.

Basic Attributes of an Exposure and Development System

Sophisticated exposure systems have been developed to address these questions with varying degrees of success. I believe a robust exposure and development system should have these attributes:

- Simple enough to use when you are out taking pictures
- Integrates visualization of the final print with the scene attributes
- Accommodates any film and paper combination
- Precise enough to produce negatives that print within half a paper grade of the predicted density range
- Self-referencing, that is it does not require reference to a calibrated standard; it does require that meters, timers, thermometers, etc. be linear, repeatable and reliable
- Produces meaningful comparisons between tested films and papers
- Accurately represents the density response of the film-developer combination as both exposure and the degree of development are changed
- Be based on first principles and be scientifically defensible.

Some Claims

The Visually Integrated Development and Exposure Control (VIDEC) System satisfies the requirements of a robust exposure-development system. It meets these challenges by replacing trial and error with a system focused on the end result, the print. The tools of the system include a graph and a special gray scale, both of which you produce with your own equipment and work habits. Using these tools in a stepwise procedure, it is now possible and, more important, practical to evaluate any scene before the camera, envision a print of the scene, know which shutter speed and aperture to use, and know the degree of development the film will require. This well crafted negative not only has the optimum qualities to produce the envisioned print, but also gives substantial opportunity for alternate interpretations during the printing process.

With VIDEC your mind's visual power to observe and imagine, discriminate and invent, organize and envision, works in concert with the craft of photography. Paper and film are tested independently but in a way that allows any combination of paper and film to be linked. By coupling a particular print paper to a particular film using VIDEC methods, the outcome of a very wide range of exposure situations can be predetermined. You are empowered to execute your visual interpretation of a scene against the full range of photographic possibilities.

The VIDEC method provides the tools to conquer four basic photographic challenges:

- Visualizing how the tonal values in the scene will look in the print
- Calculating the precise exposure
- Determining the optimum degree of development
- Matching any tested film to any tested paper.

Additionally, VIDEC helps you distinguish scenes that have photographic potential from those that do not. It enables you to predict how the range of scene brightness you perceive will actually appear in a print.

The VIDEC System rests on the repeatability of the photographic process. From tests you make using your film and print paper, you will make a simple-to-use exposure/development graph. With this graph you can make informed choices when you evaluate a scene for its photographic potential. The outcome is a negative of optimum quality for achieving the desired outcome, a fine print.

The VIDEC System accounts for all the major photographic variables - lens transmission and flare, light meter characteristics, film type, film development, print paper type and grade, enlarging lens, enlarger light source, print chemistry, and others. The system even accounts for variables that no manufacturer can control, that is, your photographic work habits, your agitation technique, water supply, and even your thermometer.

The VIDEC System is solidly based on physical realities and clear terminology. Concepts such as exposure, contrast, and sensitivity take on precise meaning. The system reveals the actual performance of your photographic materials. For example, VIDEC methods reveal important tone reproduction characteristics of any tested film. Comparing these characteristics enables the photographer to choose the most suitable film for a desired style or particular application.

Because the VIDEC System encompasses the fundamental principles of photography, it can be applied to the entire range of photosensitive materials and processes.

The Challenge

I challenge photographers to learn this new system. Make no mistake; VIDEC requires a degree of personal commitment. You need to have some experience developing film and making prints. You must have a good spot meter. You should also know how to plot a graph or be willing to learn. If you read the book, complete the exercises, and test your own materials, I am confident that your commitment will be rewarded with excellent results.

These are the major tasks you will accomplish:

- You will start using the system with the tools I provide in this book
- You will learn the system, its logic, and language
- You will print a Step Tablet Print for the paper(s) you intend to use
- You will test the film(s) you intend to use and produce your own iso-density graph
- You will use VIDEC with your own iso-density graph and STP, evaluating the scene and carefully recording the information and your choices
- You will create images that faithfully convey your intent by applying the VIDEC method to your unique sense of vision.

Navigating the Book

I want you to use the VIDEC system so the next chapter is a complete do-it-yourself tutorial. Most people get a solid, intuitive feel for the system on the first try.

A discussion of the visual foundation of VIDEC follows. The APEx system of simplifying exposure calculations is next, then the sections on testing paper and film and drawing the iso-density graph. The glossary is arranged in tutorial sequence; that is, the definitions are arranged to build your understanding of photographic principles and the specifics of the VIDEC system. The terms are also indexed alphabetically. The final section is a terse, technical description of the system. The appendix has a description of how to use your spot meter as a densitometer and some other information that may be of interest to you.

Feel free to skip around if you wish. If you find a term you don't understand, look in the glossary. All the illustrations in the book were made using VIDEC.

Let us begin!

Chapter 1 Quick Start Using the VIDEC System

It's time to give it a try! Follow the instructions to get a feel for how the system works. Don't worry that you haven't tested your film and paper yet. The information I've provided will give you results good enough to experience the benefits of the system. Go ahead; give it a try!

What You will Need

- Film – Kodak T Max 100 or Ilford Delta 100 in the size for your camera (Roll or Sheet as needed)
- A spot meter to evaluate the light in the scene
- A few exposure record sheets (feel free to make copies of the one provided at the back of the book) and a pencil
- The Iso-density Graph for the film you have chosen (found in the appendix)
- Fresh developer (D-76 for T Max 100, DD-X for Delta 100)
- The Step Tablet Print (STP) - for now use the facsimile STP found in the appendix

Follow these Instructions

1) Find a subject that won't move and a time of day when the light won't change rapidly. Make it a straightforward photograph, not too close, normal focal length lens, no filters, and bright enough for your spot meter to read the darkest area in the

scene.

2) Set the spot meter to ISO/ASA 100. If your

meter allows, set it to read directly in EV units.

When the meter is set for ISO/ASA 100, the EV reading is the same as the Luminance Value (LV), which is the measure of an area's brightness.

3) Analyze the scene by identifying the important light-toned areas and dark-toned areas in the scene. Scan the scene with the spot meter. Evaluate several areas in the scene. Record these values on the Exposure Record Sheet.

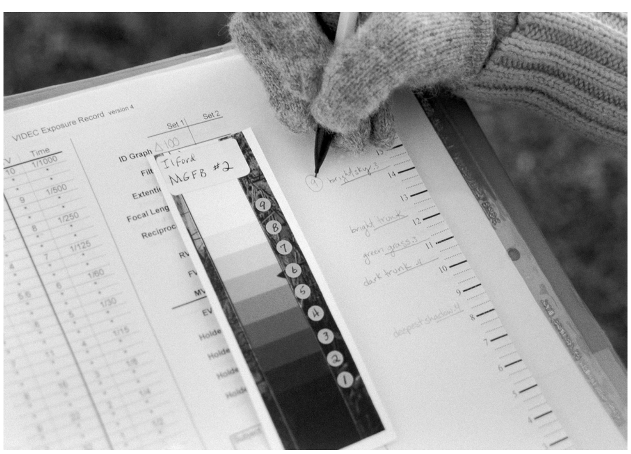
4) Record the basic information on the Expo-

sure Record Sheet. First circle the film type you will be using. Then circle the print paper on which you will print this scene. The #2 grade of any good

paper will work fine.

5) Pick the most important light-toned area and compare it to the Step Tablet Print. From the

Step Tablet Print choose the shade of gray that you want that important light-toned area to look like. Make a meter reading of that area and put a tick mark on the LV Ruler printed on the edge of the Exposure Record Sheet. Write the Step Number



from the STP associated with this reading. Jot a brief description of the measured area beside the tick mark.

6) Pick the most important dark-toned area in the scene and compare it to the step tablet print.

From the Step Tablet Print choose the shade of gray that you want that important dark-toned area to look like. Again, make a meter reading of that area and put a tick mark on the LV Ruler printed on the edge of the Exposure Record Sheet. Write the Step Number

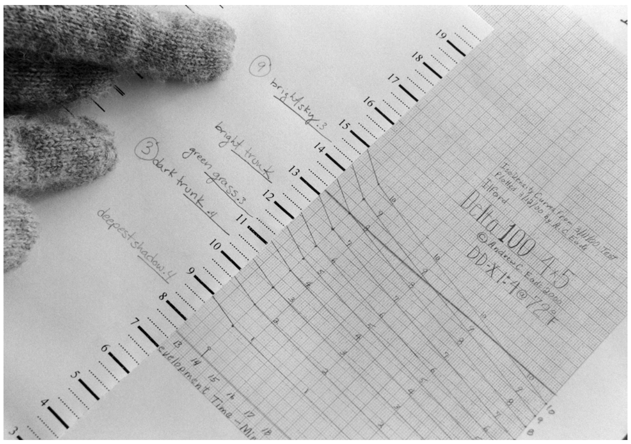
from the STP associated with this reading. Jot a brief description of the measured area beside the tick mark.

7) Find the exact exposure and development time on the Iso-density Graph.

Lay the LV ruler over the Iso-density Graph. Find the LV for the dark-toned area and place it so

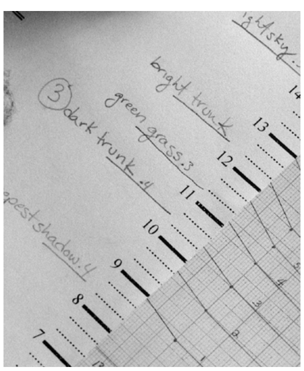
that it touches the Step Line it corresponds to. For example, if you selected step 3 for the dark shade and that dark area reads LV = 10.3, then lay the 10.3 on the ruler over the Step Line marked "3".

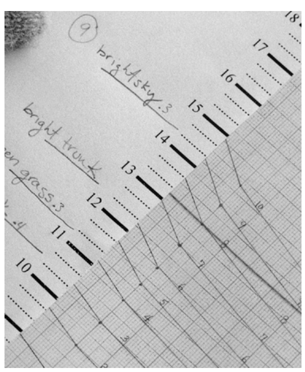
Without moving the LV ruler, find the LV for the light-toned area on the LV ruler. Then look for its corresponding Step Line. Now move the LV ruler right or left as needed to make the light-toned area LV and the dark toned-area LV touch the cor-



responding step lines simultaneously.

8) Being careful not to move the ruler, read off the development time where the edge of the LV Ruler intersects the development axis. In this



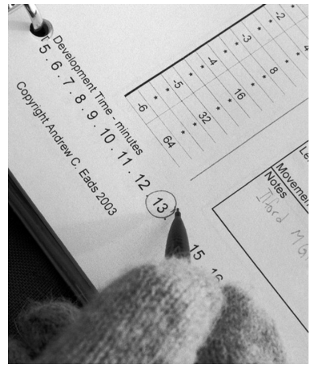


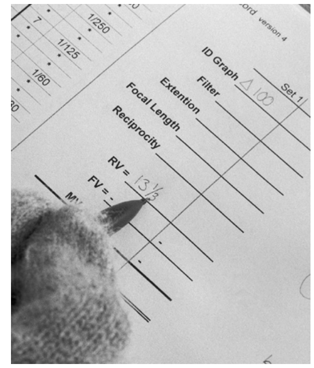
example, rounding up slightly gives 13 minutes.

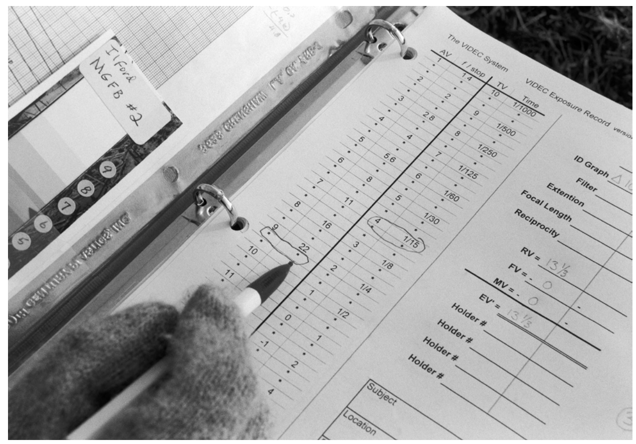
EV' is read off the LV Ruler where the RV = 0 line intersects. In this example, rounding up slightly gives 13.3.

Record the development time by circling the time at the bottom of the exposure record sheet. Record EV' in the calculation column.

To figure the f/stop and shutter speed, pick







any combination of AV and TV from the left-most columns that adds up to EV'. Circle your choices.

9) Make the exposure, then double-check your readings and calculations. If you are using sheet film, record the film holder number on the VIDEC System Exposure Record.

If you are using roll film, continue to find scenes to photograph and finish off the roll. Obviously, you are committed to using the first development time chosen. Continue to use that development time but use the iso-density graph to choose the exposure.

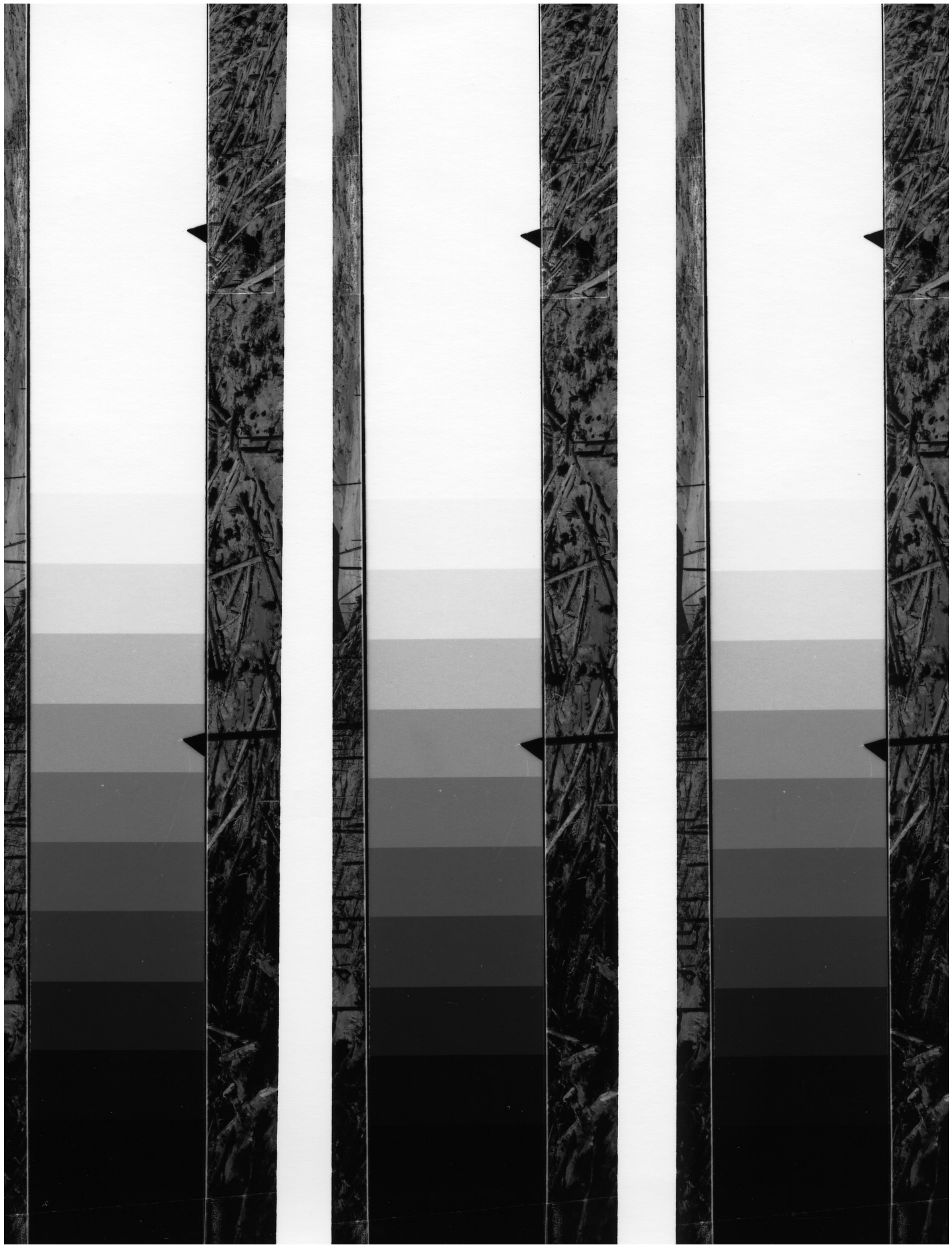
Evaluate the scene as just described and, without regard to where the high values will fall, use the exposure indicated on the iso-density graph based on the dark values.

10) Process your film for the determined time at the temperature and dilution indicated on the Iso-density Graph. Use your normal technique for agitation and other processing steps.

11) Make a straight print on a normal contrast grade of paper.

Do the shades of gray in the print look appropriate? Did the shadow detail print the way you predicted? Were any highlights muddy gray or blown out? Now, compare these negatives and prints to others you've made in the past. Was getting a decent first print difficult from the VIDEC negatives? Do you think that it will be easier to make a good final print from the VIDEC negatives?

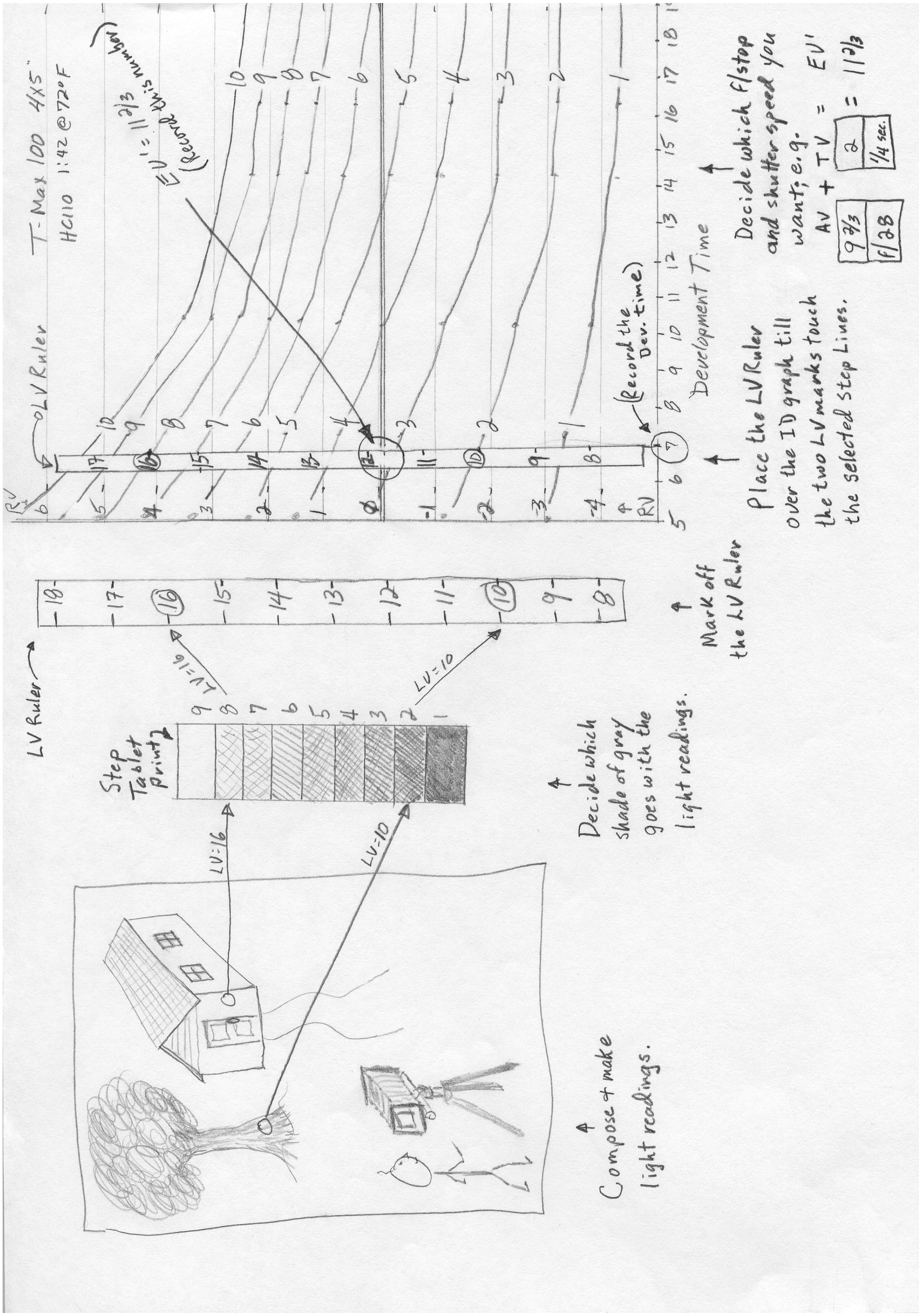
You may be startled by a few things. First, a VIDEC negative may look under exposed or under developed. Don't be put off, it will print just fine. Second, as you make more photographs with VIDEC, you may find that most of the development times are near the extremes. Again, don't worry. If your VIDEC negatives make good prints, the system is working and conventional wisdom is falling by the wayside.

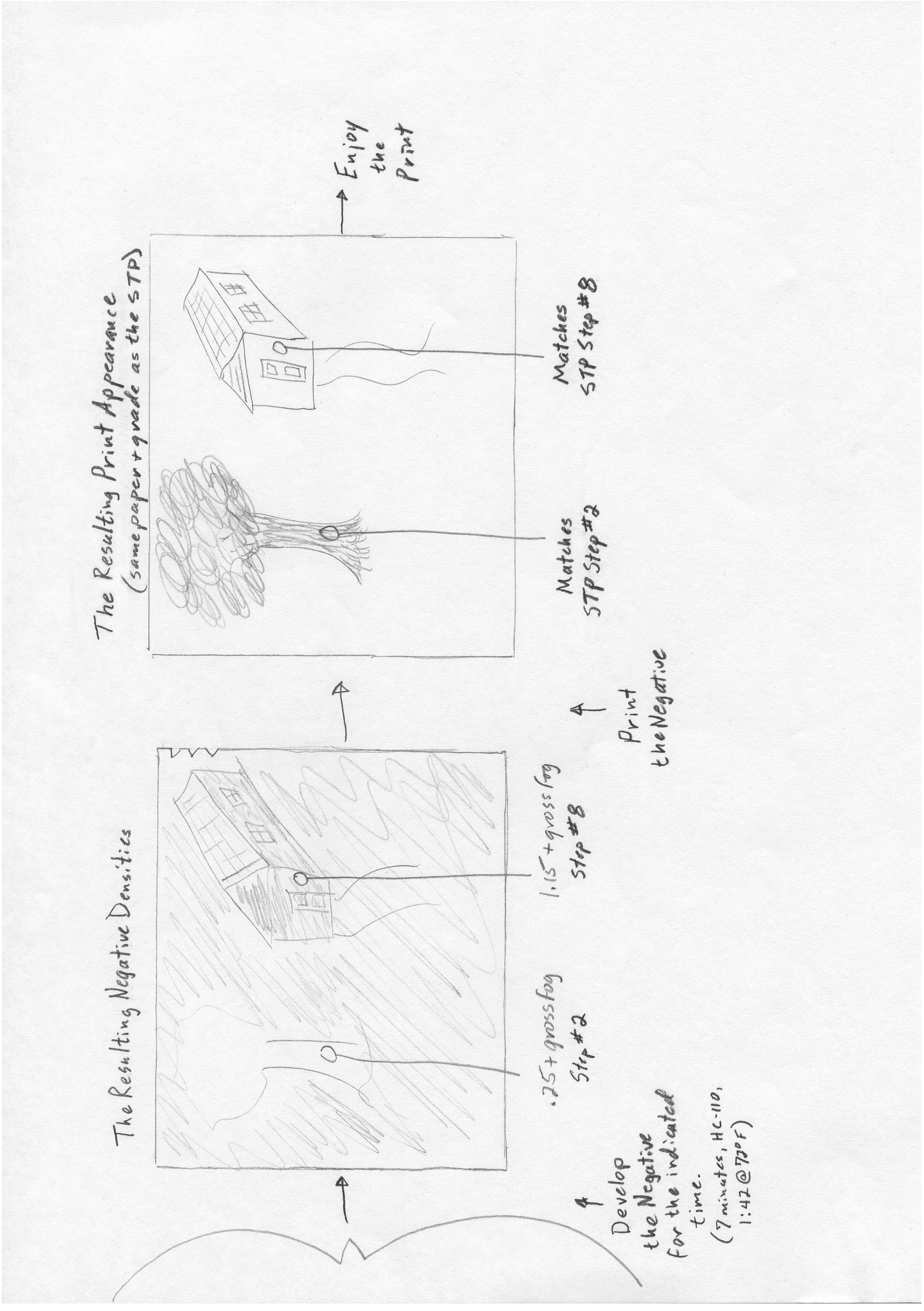


Due to limitations of the reproduction process, these are not perfect representations of the originals. It is left to you to make your own step tablet print on each paper you use. See Chapter 10 for details.

The originals of the above step tablet prints were printed from a Kodak #2 Step Tablet Negative (0.15 density increment) by enlargement with a condenser light source with a #2 filter onto Ilford MultiGrade Fiber Base Glossy paper.

Additional copies can be found in the Appendix.


Compose + make light readings.
LV:16
LV:10
Step Tablet Print
Decide which shade of gray goes with the light readings.
LV Ruler
LV=16
LV=10
Mark off the LV Ruler
LV Ruler
RV
Place the LV Ruler over the ID graph till the two LV marks touch the selected Step Lines.
(Record the Dev. time)
Development Time
T-Max 100 4X5"
HC110 1:42 @ 72°F
EV' = 11 2/3
(Record this number here)
Decide which f/stop and shutter speed you want; e.g.
AV + TV = EV'
9 2/3
f/28
2
1/4 sec.
= 11 2/3


The Resulting Negative Densities
.25 + gross fog
Step #2
1.15 + gross fog
Step #8
Print
the Negative
The Resulting Print Appearance
(same paper + grade as the STP)
Matches
STP Step #2
Matches
STP Step #8
Enjoy
the
Print
Develop
the Negative
for the indicated
time.
(7 minutes, HC-110,
1:42 @ 73°F)

Chapter 2 Effective Relationship

Mere Shades of Gray

Master photographers excel at making all the tones in the print work together to achieve the response they want from the viewer. Effective relationship is the sublime visual effect caused by the shades of gray in a print. It is a visual event that occurs when the shades of gray in the print give rise to a strong response. These visual cues may include the presence of detailed shadows, a textured white, a skin tone, or other anchor point. When the visual cues elicit the desired response from the viewer, we say the shades of gray are in effective relationship.

VIDEC facilitates achieving effective relationship at two occasions in the photographic process: when the negative is made and when the print is made. At the time you make the photograph, you translate the scene luminances to the tonalities of the print through the intermediate stage of the photographic negative. Obviously making the negative precedes making the print by hours, days, or (too often in my case) weeks. But such is the power of the VIDEC system that you can explore the possibilities well after the photograph is taken.

Let's perform an exercise now to refine your personal sense of effective relationship.

An Exercise for the Visual Sense

This exercise will sharpen your understanding of how shades of gray relate to each other in a black and white print. Find the Step Tablet Print that came with this book. Now find several photographs that reflect your taste. They should be original prints or very good reproductions from a fine book or calendar. We will ignore for the moment that the photographer may have burned, dodged, bleached, masked or otherwise manipulated areas of the print. For now we are interested in what works visually, not how it was done.

Find a comfortable place with strong lighting. Lay the Step Tablet Print over the print and move it around. Compare the individual shades of gray on the Step Tablet Print to important areas in the photographs. Be sure to compare skin tones, the highlight on the cheek, and the shadow under the jaw, dark and light objects, grass, bark, concrete, clouds, water, or whatever else is important to you. Look at areas that are situated in direct light as well as in shadow. Look at textures and think about the properties of light that caused them to be revealed. Look very closely for fine detail revealed by contrasting shades.

Observe the balance of values in a good high-key print, then compare your observations to the balance in a low-key print. (A high-key photo is one in which most of the shades of gray are very light; e.g., a fair-complected ballerina in a white outfit against a white background. A low-key photo is one in which most of the shades of gray are very dark.) Note how the tonal range affects the emotional impact of the print. What emotional responses did you experience as you observed high- and low-key photographs?

How many sources of light can you find in each photograph? Do they cast sharp or diffuse shadows? Perhaps the photograph is illuminated with both sharp and diffuse light sources? How close are the sources? Does fine detail play a role in the impression the print makes?

Were you surprised by any of your observations? Was foliage lighter or darker than you expected? Were skin tones more complex than you thought? Did you find a pure white and a deep black in all of the photographs? Have you found any prints that had neither a pure white nor a total black, yet were visually effective? Did any of the prints stir your desire to make new photographs with a visual interpretation you have not yet tried?

If you observe a number of prints over a period of time, you will gain an appreciation for the effective relationship between shades of gray representing highlights and shadows, skin tones, clouds, metal, etc. By making this kind of observation an ongoing effort, you will strengthen your own sense of effective relationship. In time, your feel for effective tonal relationships will become intuitive. This finely tuned sense will greatly aid your ability to see beyond the expected, creating photographs that will astonish your audience. This exercise is especially powerful if you practice it regularly.

The Step Tablet Print – the Key to VIDEC

The Step Tablet Print (STP) is a portable visual record of the shades of gray that a particular photographic paper will produce. The STP gives you specific information about how your photographic paper behaves.

It enables the "Visually Integrated" part of the VIDEC acronym. As you strive for effective relationship in the photo opportunities that pass your way, you can correlate the values you see in the scene with shades of gray on the print paper you choose. The other VIDEC tools will tell you what exposure and development to give the film to get an optimum negative for that paper. (Refer to the master illustration in Chapter 1.)

VIDEC does not work without the Step Tablet Print. Not just any gray scale will do. The best one to use is the one you make in your own darkroom on your favorite paper(s). The procedure for making your own is described in Chapter 10.

The Dynamic Range of the Human Vision System

We would be extinct if we could not extract more from the visual world than a camera can record. Our vision system takes cues from the scene and creates for us the sensations of color, depth, scale, brightness, motion and others. Such is the power of vision that a person with sight in just one eye can still perceive depth. In short, we carry a very sophisticated, real-time image processing computer right between our ears.

Cameras, like our eyes, capture light rays and organize them into images with remarkable properties. Unlike human vision, cameras are mechanically literal. The laws of physics strictly govern their workings. Let us explore some of the important relationships between the scene we see and the image in the camera.

To clarify, the term for the light we measure with a photographic light meter is luminance. It can be light that is either reflected from a surface or emitted from it. The impression that luminance makes on our vision is called brightness.

The way we perceive light and dark is relative. Black to a physicist is the absence of all light. But to our visual sense, an area will appear black if it is a certain amount less bright than the area around it. That is, the impression of black is relative. For example: a black cat's fur reflects a small but measurable amount of light. It is always a fixed percentage of the light falling on the fur. But we perceive the cat as black relative to its surroundings.

A television set in the normal light of the living room provides a good example of brightness perception. If we look at the screen when it is turned off, it appears to be a dark gray tone. We can measure the luminance of the dead screen, that is, the room light reflected from it.

Now, without changing the room lighting, we turn on the set and look at the TV picture. We will see a full range of tones from light to dark. If we measure an area on the screen that looks to be black, it will have at least the same luminance value as when it was turned off. Our vision system has interpreted the visual cues, specifically the range of luminances on the screen, as having a range of brightness from black to white.

The Perception of Brightness

Your visual system always works to put tonal values in effective relationship no matter how great or small the brightness differences may be. Let's consider two scenarios.

Some people are sitting in a lunchroom with sunlight streaming in from a large window to the left. A woman is sitting in front of me wearing a brilliant white, textured satin blouse. Just beyond her is a black woman facing the sun; her hair is in shadow. I can see detail in the blouse and detail in the dark black hair. The measured difference between the brightest and darkest area is 10 LV units (stops) or 1,024:1. Contemporary slide films capture around 6 LV units or 64:1. My eye, as would yours, easily encompassed the full range of the scene.

While at a motel I saw an interesting shape and form in the design of a pristine white shower stall. I decided to take a photograph. I measured the luminances with my spot meter. It couldn't be! The brightest area was only 1.1 LV units (2.14:1) brighter than the darkest shadow in the scene and yet I perceived a wide brightness variance in the curves of the tub.

These two scenarios show a world full of extremes that our visual apparatus handles with ease. What all good photographers master is getting the shades of gray in effective relationship across a wide range of circumstances. Recognizing that there is a difference between the visual impression of a scene and its physical attributes is the first step.

The Problem is Key to the Solution

Human vision gives priority to interpreting the luminance differences between objects in our field of vision. A camera cannot interpret; it can only project a faithful image of the scene luminances onto the film. But the film and the print paper add their own flavor, that is tonal transformation, to the resulting print. Imagine if we could devise a way to see through the intermediate steps to the print; somehow accounting for the tonal transformations the film and paper will cause. Imagine a direct method, a sort of a bridge, to reliably get a truly optimum negative. This is exactly what the VIDEC System empowers you to do.

As the Quick Start exercise demonstrates, the brightnesses in the scene can be correlated to intentionally chosen grays on the print paper (the step tablet print). At the same time, the optimum exposure and development time are calculated using the iso-density graph. Combining your knowledge of effective relationship with a worthy subject, you will master the medium.

Know Your Limits

While human vision has remarkable range, it does have limits. Our ability to distinguish small luminance differences decreases as the illumination decreases. In bright sunshine we can see the individual hairs on a black cat but under the dim light of the moon we can only see the gross form of the cat. Our perception varies between these two extremes.

This has important implications for the photographer. First, it points to the problem of anticipating the effect of light. In some situations, we can see a range far greater than we can record easily with a camera. In others, we can see subtleties of color and shade that may translate into a bland-looking photograph. We must learn how our eyes interpret the scene. We have to recognize the conditions that make good or bad photographs no matter what our eyes are telling us.

Second, it points to the challenge of interpretation. Do we choose to reveal the subtle shades of the black cat's fur or do we envision a mysterious silhouette?

Third, it points to the problem of the viewing conditions when the scene we are observing is a photograph. Photographs with large areas of dark detail may look fine under strong illumination but appear heavy and lifeless under weaker illumination. In fact, a print must be made with the final viewing conditions in mind. Two outstanding books on the subject of printing are *The Print* by Ansel Adams and Kodak's *Quality Printing* which is out of print at this writing.

This brief discussion of brightness and luminance touches the study of human visual perception for our immediate needs only. There are other areas that are of interest to the photographer but are beyond the scope of this book.

Envision It Outside!

Using the same STP you used to examine prints, go outside and examine a variety of scenes. Bring a friend along and find a scene you might want to photograph. Pose your friend in the scene. Imagine that you are going to take this picture. What shade of gray from the STP will you associate with the skin tone of your subject, or the highlight on the cheek, or the shadow side of the face? What shade of gray will you associate with the deepest shadow in the scene or with the brightest highlight? What of the values in the background? How do the relationships change if you move from direct sun to open shade?

These are the very associations that connect the scene with your intention of how the print should look with the exposure and development the negative must receive to be printable. Your finely tuned aesthetic sense will be coupled to the best photographic craftsmanship using the VIDEC system.

Chapter 3 The Film-Based Photographic Process

The Scene and its Optical Image

Have you ever burned a leaf with a magnifying glass? The magnifying glass functioned as a simple lens, collecting and focusing the radiation of the sun. There was enough energy in that image of the sun to raise the temperature of the leaf and cause it to burn. In the same way, the lens on our camera focuses the radiation reflected or emitted in a scene onto the film. The miracle of photography is that it takes only a small amount of light energy to make a fine photograph; a tiny fraction of the energy needed to burn the leaf!

Light has a physical nature; it is energy. Physicists note that one of the properties of energy is the ability to cause change. We know from our daily experience that plants use light to make their own food through the process of photosynthesis. The color in the curtains and couch fade when exposed to the strong light of the sun. The effect of sun exposure on human skin ranges from the healthful production of vitamin D to severe sunburn.

Light also causes changes within our eyes as the lens focuses images on the retina. These changes are translated by our nervous system into the sense we call vision. Our eyes constantly refresh themselves so we see the changing world around us as it happens.

Light is the form of energy that makes photography possible. The film and paper we use are coated with materials that are invisibly changed by the power of light. These changes are made visible and permanent by chemical processes. Virtually all films and papers make use of the light sensitive nature of certain chemical compounds, the silver halides. These silver halides are suspended in gelatin and coated onto a film or paper base. The coating is called the emulsion.

Fortunately for us, the whole process is predictable and repeatable. We can test and measure how a film responds to light by using a plan to standardize our procedures and to interpret the results.

Exposure

When a photographic material is exposed to light, the photosensitive material is changed in relation to the amount of light falling on it. At this stage, the change is invisible or latent. It takes a certain amount of exposure before any measurable change occurs. But once the emulsion receives that minimum amount of light, the more light that falls on the photosensitive material, the more the material is changed. Once all the photosensitive material has been changed, adding more exposure has no further effect.

Processing

To make the latent image visible and permanent, we use a chemical process called development. The chemical called developer changes the exposed silver halide particles into metallic silver without affecting the unexposed particles.

Developer also has the effect of amplifying the exposure. The small change caused by exposure to light is made many times more effective by the action of the developer. The amount of amplification is dependent on the chemical properties of the developer.

When film is placed in developer, the exposed silver halides begin to be converted. The longer a negative is developed, the greater the number of exposed silver halide particles will be changed. The strength of the specific developer formula, that is its concentration also affects how fast the development process will proceed. Development time, developer temperature and concentration affect the degree of development. Thus both exposure and degree of development influence the amount of silver halide converted to metallic silver.

When the desired degree of development has been reached, the film or paper is put in a weak acid solution called stop bath. Its job is to stop the action of the developer and extend the life of the next chemical. Some photographers use a water rinse instead of stop bath; this slows development substantially by diluting the developer.

At this point in the process, both the undeveloped silver halides and the metallic silver are present in the emulsion. The developed image is barely distinguishable and the undeveloped silver halide is still light sensitive. To obtain a useful negative, the undeveloped silver halide must be removed. The chemical, which dissolves away the undeveloped silver compounds, is called fixer (to fix or make permanent). Like sugar in warm water, the halides dissolve away into the fixer. After fixing, only the silver remains. The final steps are to wash the fixer out of the emulsion and dry the film.

In summary, the amount of metallic silver remaining in the film after processing is related directly to the exposure and development. The remaining silver forms the image we can view, project, and print. The measure of the visible image is called optical density.

Density, the Response of Film to Exposure and Development

What we see when we look through a negative is light modulated by density. If you compare the negative to the scene, you will see an obvious correspondence. Light objects in the scene are dark in the negative. Likewise, dark objects in the scene appear light (or clear) in the image on the negative. Density is the response of photographic material to exposure and processing.

The density that results from exposure and development is easily measured. With careful testing and record keeping, we can predict how our film will respond to different amounts of light.

The ability to predict the response of photographic materials is crucial to any exposure/development system. Sensitometry is the science of measuring photographic response; that is, optical density as the response to both exposure and degree of development.

When light strikes most materials it is absorbed, reflected, or transmitted. Usually it is a combination of these three. When light strikes the silver remaining in our processed film, a small amount is reflected, some is transmitted, some scattered, and the balance is absorbed. When we hold a negative to the light, we can see the image because the varying amounts of light-absorbing silver correspond to the intensity of the light patterns imaged onto the film.

The light that makes it through the negative can be measured; here's how. If we measure how much light is striking the film and compare it to the amount being transmitted, we obtain a value called optical density. Density is a measure of the fraction of light absorbed by the negative.

Measuring Optical Density

A device called a densitometer is used to measure the optical density of a negative. A densitometer has a stable light source, a probe to examine a small area of the negative, and the electronics to measure the light. Densitometers read out directly in optical density units.

Good densitometers are not cheap, but they are a common tool in professional processing labs. Many amateur photographers find them a valuable tool too. To make use of the VIDEC System you will need access to a densitometer. If you do not have access to one, there are ways of using a good spot meter for the purpose (see Appendix). Since you need a spot meter to make readings when taking pictures, you can get double duty from your investment.

How the Density Numbers Work

There is an important relationship between the values of optical density. First, a density of 0.0 means that no light was absorbed, reflected or scattered; all the light was transmitted. A density of 0.3 means that one half of the light was transmitted; half the light was absorbed. A density of 0.6 means that one quarter of the light was transmitted; three quarters was absorbed. A density of 0.9 means that an eighth of the light was transmitted; seven eighths was absorbed.

Each increase in optical density of 0.3 means that one half as much light was transmitted. Each decrease of 0.3 density means that twice as much light was transmitted. The amount of light transmitted must always be less than the amount of light falling on the negative.

Just as a negative has density so does a photographic print; it is called reflected density. A processed photographic print is actually a negative lying in intimate contact with the surface of the paper. However, there is a big visual difference between film and paper.

The light striking a negative passes through the emulsion just once. The light striking the photographic paper emulsion passes through the emulsion twice on its way to the eye. First it passes through the silver on its way to the paper base. Then it is reflected by the paper-base back through the silver to the eye. The density effect of the single layer is doubled.

A densitometer that reads the densities of negatives is called a transmission densitometer. A densitometer that reads reflected densities is called a reflection densitometer. Some instruments combine both functions in one package.

Making a Positive Print

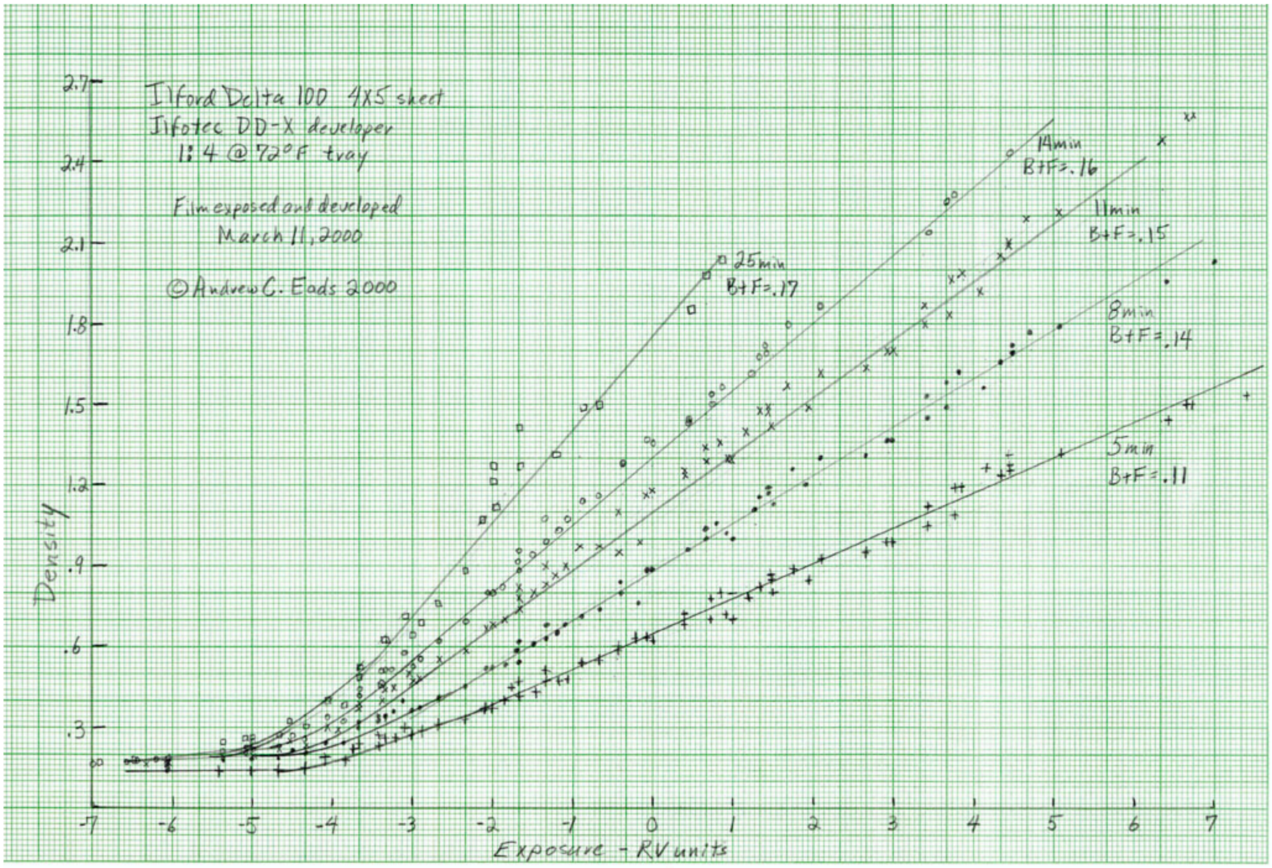
To make a positive print from a negative we need another negative working material. This is a clear cut case of two negatives making a positive. If we place a properly exposed and processed negative between an even light source and an unexposed negative material, the light from the source will be modulated by the negative: the dense areas holding light back resulting in light areas on the print and the clear areas allowing more light to pass resulting in dark areas on the print.

A Special Case: Dye Images

Color negatives, slides, prints, and chromogenic black and white films use silver compounds as the photosensitive detector but there is an important difference in the way the image is formed. The exposed silver is removed during processing and special dyes are formed in its place to create the image we see. These dyes absorb light like silver but do not scatter the light in the same way. The reasons for this behavior are outside the scope of this book but the effects are accounted for in the normal VIDEC System testing procedure.

The Fathers of Sensitometry

In the early days of photography, the photographic process was not well understood. Many scientists studied photographic materials to learn the secrets of the new technology. In 1890, two scientists, F. Hurter and V. C. Driffield, made a major contribution to the science of photography, which today bears their names. By plotting a family of curves on a simple graph they showed the relationship between exposure, degree of development, and density. The curves are called the H&D curves



or, interchangeably, the characteristic curves. The VIDEC System rests on the foundation they laid.

About Graphs and Formulas

We can often use a formula to predict the result of some action. If you drive for two hours at 50 miles per hour, how far will you travel? We can calculate the answer easily. By applying the formula "distance = rate x time," we know the answer is 100 miles.

Other relationships are not as simple as our driving example. Sometimes it is just not possible to come up with a simple formula that will give us the answer. If we perform a test and collect the right data, however, we can plot the results on a graph and visualize the results. By simply connecting the dots, we can make a very close prediction of the in-between values.

The complex relationship between exposure, development and density is best represented by a graph and is a good way to learn the characteristics of a film and put this knowledge to work. Graphs like the H&D curves above are useful because they tell us how the density changes when we change the exposure, development conditions, or both.

These curves reveal the sensitivity of the film. Examine the curves and you will find that the film has no sensitivity to exposures less than -5 RV units. As we increase exposure to -4 then to -3 we see the film respond with more and more density.

The curves can be used in reverse. If we want to know how much exposure it takes to get a particular density at any of the tested development times, the curves will tell us. This intimate knowledge of the film combined with a simple way to test our print paper gives us the power to solve the old problem of how much exposure and development do I give my negative.

We will extract the information needed to plot the Iso-density curves from the H&D curves. We will explore exactly how to do this in Chapters 9 and 12.

Chapter 4
Good Negative Quality

Good Quality is Relative

A good negative is relative to the purpose of the photograph. It is relative to your way of looking at the world. It is relative to your print paper. Though it is an intermediate step to the final print, the characteristics of the negative are critical to the appearance of the final print.

Personal interpretation plays an important role in determining desirable photographic qualities. The smooth, grainless tones of a large format negative are lovely, but the photojournalist may want the psychological punch of tight grain and strong contrast. Personal interpretation should drive the technical considerations.

Traditionally negative quality has been judged by technical considerations such as graininess, fog, sharpness, density range, shadow detail and contrast. Note well that these technical qualities are all interrelated. If you attempt to maximize one, you may sacrifice another. The challenge is to optimize all the factors together to achieve your desired outcome.

Optimization is the clear purpose of the VIDEC System. At the same time, VIDEC allows you to easily try new combinations of film and print paper. A good starting point for information about a film or paper is the manufacturer. Many of the major manufacturers publish useful guides that aid in selecting the best film and developer for a given application.

Some Important Qualities of Negatives

The more exposure a negative receives, the more grains of silver will be developed. The more grains of silver developed, the greater the appearance of graininess in the print. Thus, to minimize graininess, keep the exposure as low as possible.

On the other hand, to obtain detail in the shadow regions of the print the negative must have adequate printing density that only results from adequate exposure. A particular film simply will not record light below a certain exposure. Efforts to reduce graininess by reducing exposure come head-to-head with the absolute need to give the film a certain minimum exposure.

To make a print that achieves its full range of tonalities, the print paper must be exposed to just enough light to show detail in the highlights and not so much that the shadow detail turns black and empty. The difference between these two exposures is called the exposure range of the photographic paper.

The difference between the shadow density and the highlight density of the negative has to match the exposure range of the print paper. A #2 grade paper typically has an exposure range of 1.2 log units (there is considerable variation from paper to paper). Therefore the technically good negative should have a density difference of 1.2 density units between the deepest shadow and the brightest highlight. (See the technical description of VIDEC in Chapter 14 for a more detailed analysis of negative density range and print exposure range.)

For low-contrast subjects (i.e., with a small scene luminance range), the degree of development may be increased to obtain the desired negative density range. The drawback is that increasing the degree of development increases the apparent graininess of the printed image.

For high-contrast subjects (i.e., with a large scene luminance range), the degree of development may be reduced to obtain the desired negative density range. Reduced development has the effect of reducing the overall sensitivity of the film.

With this understanding, we can construct a rationale for exposure and development. That is, we can select the optimum degree of development for the luminance difference presented by the scene and simultaneously choose the minimum exposure that will record the detail we want to capture.

Remember that we are talking in a strict technical sense. While there are valid aesthetic and technical reasons for bending the rules, every serious photographer must consider these factors when learning to master the medium.

Camera Settings and Exposure

The word exposure is tossed around casually; too casually sometimes. Let me explain. Exposure is not "*f/8* at 1/125 sec." Those are only camera settings; the exposure controls. Exposure occurs when something is exposed to radiation for a period of time.

In photography, the radiation is light and the something is film or paper. The longer the time, the greater the exposure. The stronger the light, the greater the exposure. The camera settings control the amount of exposure delivered to the film. You balance the *f*/stop against the shutter speed for the best visual effect (i.e., the sometimes-fiendish choice between motion stopping, depth of field, and optimum sharpness).

If you were to photograph a building during the day in sunlight and then again when the sky is heavily overcast, the camera settings would be different. This is easily understood. There is not as much light on the building when the sky is overcast as there is in the sunshine. To get the same effect on the film (density) at both times, the exposure to the film must be the same for both frames. Compared to the sunny day, you must either increase the aperture of lens or set the shutter for a longer time to deliver the same exposure to the film.

About Film Speed

Film speed is a number selected to achieve the highest likelihood of obtaining an acceptable photograph under a wide variety of conditions. The light meter uses this number to calculate the *f*/stop and shutter speed.

It was determined very early in the history of photography that the best strategy for reproducing a photographic image is to capture the scene on a low contrast material (photographic film) and print it on a high contrast material (photographic print paper). This approach minimizes the effects of over or under exposure and processing variations. So, with low contrast film, how do you choose the best exposure?

A great deal of serious scientific study has gone into the process of determining film speeds. Manufacturers and standards bodies (ISO) use statistical methods to determine the luminance range of common pictorial situations, variations in processing from lab to lab, and variations between cameras. Processing parameters are specified. Add to this an understanding of what the general public considers to be an acceptable print and you have a "film speed". At the end of this detailed process, the film manufacturer stamps the film box with the film speed.

This statistical approach has strengths and weaknesses. For general-purpose photography, a properly determined film speed will ensure you are pleased with the family vacation photos. Film speed is also a good relative indicator of the suitability of a particular film to various lighting conditions.

Outstanding Results

But outstanding results in black and white photography are rare with the statistic-based approach. For the serious photographer, the conventional notion of film speed falls short of being useful for the range of conditions routinely encountered.

The misapplication of film speed in other systems of exposure control often results in a gross misunderstanding of the fundamental photographic relationships. The effects of characteristic curve shape and the shift in sensitivity as development times are changed are utterly lost.

The principles behind VIDEC avoid these complications, serving instead to clearly reveal the true nature of the photographic process. At the same time, VIDEC principles lead to unprecedented mastery of the medium.

Chapter 5 Light Meters

Introduction

Light meters measure the light from a scene and return useful information to the photographer. Meters have three major parts — a light sensor, a display, and a calculator. The sensor detects the intensity of the light. The display gives an indication of how much light is falling on the sensor. The calculator takes that readout and combines it with the film speed to give the camera settings (i.e., f stop and shutter speed). Some meters also have an optical aiming device.

Modern meters take advantage of the power of light to change the behavior of certain materials. For example, when exposed to light, the metal selenium generates a small voltage. The compound, cadmium sulfide, changes resistance. In a charge-coupled device, exposure to light depletes a known electrical charge. In all these cases, changes are a function of light energy falling on the material. The change can be measured with sensitive electronic circuits and displayed in convenient units for our use.

Meter Types

There are two general categories of photographic exposure meters — reflected and incident. Reflected light exposure meters are the type used in the VIDEC System, but it is useful for us to study both.

Incident Meters

Incident-light exposure meters measure illuminance. Illuminance is the intensity of the light falling on the subject. Incident meter readings are based on the assumption that light reflected from the lightest and darkest objects in the scene will fall within a certain range. The exposure settings calculated by an incident meter are based only on the intensity of the light <u>falling on the subject</u>. It does not matter that the subject may be black velvet or white satin. An incident meter only "sees" the light source; it does not "see" the subject.

Readings must be taken from the subject position. If you cannot physically get close to your subject, you must simulate the conditions to obtain a valid reading.

An incident meter can be used to measure the contrast between the highlight side and the shadow side of the subject. But an incident meter cannot account for the brightness of the white satin and black velvet in the shadows. It cannot directly measure the luminance of specific areas in the scene. This limitation makes the incident meter unsuitable for the VIDEC System.

Professional photographers often use incident meters because they give good information about the intensity of the various light sources in a scene. They provide a consistent means to record a scene without having to interpret every tonality. Careful photographers test their incident meters and films to learn just what film speed to use to get the best results.

The Reflected-Light Meter

Reflected-light exposure meters measure luminance (LV), the light reflected or emitted from the area in the scene before it. In use, a reflected meter is pointed at the subject from the camera position.

All of the luminance sources within the view of the meter are averaged in the reading. Many hand held meters have an angle of acceptance of 10 to 15°. Meters with a small angle of acceptance (usually 1°)

are called spot meters. Spot meters use a low power telescope as an aiming device to show the exact area being measured. Other meters encompass angles of view up to 30° and are simply pointed in the general direction of the subject.

The VIDEC method works best with a 1° spot meter because the 1° angle is usually small enough to isolate the important luminances in a scene.

Reflected light exposure meters are more complicated to use than incident meters. As you know, a scene will have light, medium and dark objects, highlights and shadows. So where do we point the meter? With some experience we learn to average these readings and "place" the exposure. But there

is another way to use the spot meter that achieves a high degree of precision.

Because spot meters give one reading for each area you point it at, that reading is directly related to the luminance of that area. By making a simple adjustment, any good quality spot meter can be used to give accurate luminance information for individual areas in the scene. In the VIDEC system, this information is used to determine both the correct exposure and the optimum degree of development for the negative. The chapter on APEx describes the entire procedure.

Using the Reflected Light Meter

For a reflected meter reading to be accurate, the reading must be made from the camera position. The closer the meter is to the lens the better. For example, glossy surfaces reflect radically different intensities depending on the observer's position. A person looking at a shiny car may see the deep color of the paint job; another person standing just a step away may only see the glare of the sun. If you make a reflected reading too far from the camera position, you may be reading a reflection that is not seen by the camera or vice versa. (A clever pro taught me a neat trick for cameras with both a removable lens and film back. Once the camera is set for the view you want, just remove the lens and the back and make your readings right through the camera body.)

Many reflected meters also display the readings as an EV number. EV numbers are very useful in the VIDEC System. They are explained in depth in Chapter 7.

Some Problems With Light Meters

Wonderful as they are, exposure meters are prone to certain problems that are matters of design, construction and adjustment.

A good exposure meter will have proper spectral sensitivity. That is, it will respond to different colors of light the way the photographic film does. However, some meters respond to infrared or ultraviolet light as well as to visible light. Neither our eyes nor normal film are sensitive to this light. If a subject is reflecting or emitting this non-visible light and the meter reads it, the reading will be incorrect. This is a very difficult problem to detect, and it can cause havoc when using the meter to test a film.

A meter may be out of calibration if it gives a reading that is too high or too low. Usually, a simple adjustment made by a competent repairman will fix the problem. Or, the photographer can compensate by adjusting the film speed on the meter. Some meters have an adjustment accessible to the user. Be cautious if you make your own adjustments; you may not be able to restore the meter to its original setting.

When a meter reads one luminance correctly but not another, the meter is said to be non-linear. For example: if a white wall in direct sunlight is 8 times brighter than the wall on the shadow side of the building but the meter says it is only 6 times brighter, then the light meter is non-linear. Obviously a non-linear meter will cause serious problems for the photographer trying to attain accurate exposure under a variety of conditions. Non-linearity is caused by maladjustment, flare (in which case it may only occur when conditions induce flare), defective components, or poor design.

If you want increased satisfaction in photography, invest in a good exposure meter. In the long run, a good exposure meter will earn its keep by dramatically increasing the number of successful exposures you make.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Chapter 6 System Groupings for the VIDEC System

Systems

All the things that influence the photographic process can be grouped into systems. System groupings help us see which aspects of the photographic process are independent and which interact.

The VIDEC System Group

For the practical application of the VIDEC System, the major groupings are:

- Scene System - all the qualities of light in the scene encompassed by the lens
- Imaging System - camera, lens, filters, magnification, flare, shutter speed, aperture
- Human Observer – our incredibly adaptable visual system, not easily quantified
- Photosensitive System – the film, developer, camera, lens combination
- Exposure Evaluation System - light meter type, scene evaluation method and exposure/development calculation method (e.g. the Zone System, VIDEC, incident light method)
- Printing System - enlarger, lens, paper, developer, light source type, magnification, safelight, drying method
- Print Viewing System - lighting intensity, direction, color balance; the relative brightness of the surround, viewing distance from the print or transparency

Alternate System Groups

There are other ways of grouping photographic and related systems which are useful to know. Here is a partial list:

- Chemical Systems - developers, fixers, toners,
- Optical Systems - camera lens, enlarger lens, camera flare, lens flare, optical qualities of enlarger light source, magnification
- Measuring Systems - light meters, beakers, densitometers, timers, rulers and scales, thermometers
- Control Systems – shutter speed selector, aperture scale, filters (neutral density and color), voltage regulators

Chapter 7 The APEx System - Simplifying and Understanding Photographic Exposure

Making Life Easier

Photographers have been hunting for easier ways to record their exposure data since the first time someone tried to test an emulsion. I am no exception. I was driven by the desire for a simple way to represent the real exposure delivered to the film. As I examined the manufacturer's characteristic curves for various films, I was frustrated by the term "log relative exposure." There had to be a way to pin a real number on the exact exposure from the combination of reflected-light reading, aperture and shutter speed.

My research led me to an existing approach called APEx, which stands for Additive system of Photographic Exposure. APEx is kind of shorthand that simplifies photographic calculations. It has the added benefit of revealing important relationships in photography. It uses whole numbers to represent f-stops, shutter speeds and film speeds. The APEx system is similar to other systems such as the Light Value Scale system (LVS) and the Exposure Value System (EVS).

The APEx system has been extended to include values not normally found in the official descriptions. The common definitions and usage are preserved to minimize confusion. However, the system in its original form has some weaknesses. I have taken the liberty of using adjusted values for the sake of clarity. I will note where the adjustments have been made.

The Half/Double Relationship

If you were measuring luminance values in a scene with your reflected-light meter and one area was twice as bright as another, the APEx numbers for the two areas would be different by 1 unit. If one of the areas were four times brighter than the other, the APEx numbers would be 2 units different. Anything that causes a doubling or halving of light energy is represented by a change of 1 unit in the APEx system.

Photographers use such relationships all the time; they call this change a stop. The sequence of apertures and shutter speeds on all modern cameras follows the pattern of halving or doubling the light energy. The intensity of the exposing light is moderated by the aperture. The duration of the exposing light is moderated by the shutter speed. Together they form the exposure controls.

Aperture f-stop	Aperture Value AV
1	0
1.4	1
2	2
2.8	3
4	4
5.6	5
8	6
11	7
16	8
22	9
32	10
45	11
64	12

Shutter Speed Seconds	Time Value TV
4	-2
2	-1
1	0
1/2	1
1/4	2
1/8	3
1/15	4
1/30	5
1/60	6
1/125	7
1/250	8
1/500	9
1/1000	10

For example, in the APEx system, for the f-stop *f*/8 the Aperture Value (AV) is the number 6. The Aperture Value 7 (AV 7) is the f-stop *f*/11. The Time Value (TV) 4 is the shutter speed 1/15 second. Likewise, TV 9 is the shutter speed 1/500 second.

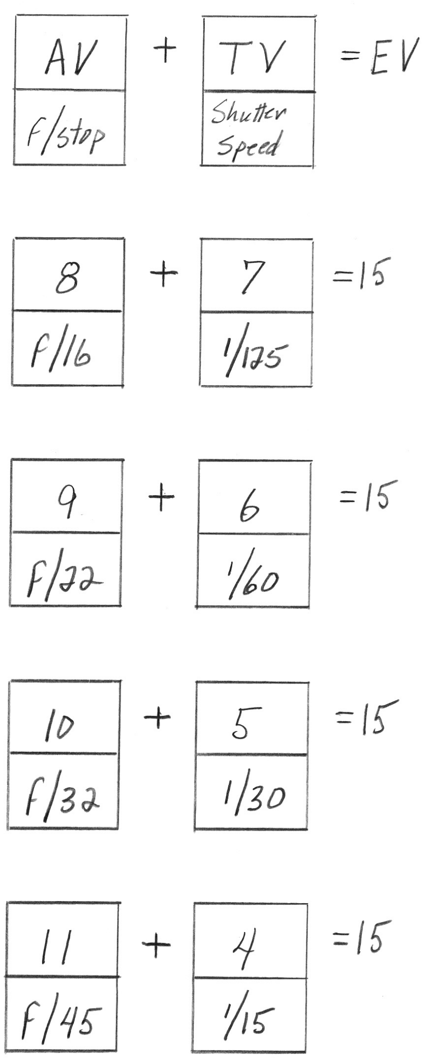
The Reciprocal Relationship

Let's say that your light meter gives you the aperture and shutter speed combination of *f*/16 at 1/125th second . If you add the AV for *f*/16 to the TV for shutter speed 1/125 second you get:

8 + 7 = 15

The sum of AV plus TV is the APEx value EV. If you look at the AV and TV tables, you will find that any combination of aperture and shutter speed that equals EV 15 will have the same exposure controlling effect as *f*/16 at 1/125th second.

The formula for this reciprocal relationship is



simply:

EV = AV + TV

Note: EV stands for Exposure Value, but that is a misnomer. EV does not represent the amount of exposure delivered to the film. It represents the degree of exposure control imposed by the combination of aperture and shutter speed. If, by changing either the aperture or shutter speed you increase the value of EV by one unit, the exposure delivered to every single grain of silver on the film will be reduced by half. Likewise, if you decrease the value of EV by one unit, the exposure delivered to the film will double.

As you might expect, film speed is represented by the APEx term SV for Speed Value. The luminances of objects in the scene are represented by the APEx term LV for Luminance Value.

The APEx system relates film speed (SV), shutter speed (TV), aperture (AV), and the reflected-light reading (LV) in a beautifully simple way. You simply add the appropriate numbers to get the correct settings for your camera. The formula is Exposure Value equals the Luminance Value plus the Speed Value.

EV = LV + SV

Film Speed (ISO)	Speed Value SV
25	-2
50	-1
100	0
200	1
400	2
800	3
1600	4

Luminance (candela/m^2)	Luminance Value LV
18	7
36	8
72	9
140	10
290	11
570	12
1100	13
2300	14
4600	15
9200	16

Note: The APEx number series are indexed for our convenience. For example: 1 second = TV 0. One second is a convenient anchor point as is *f*/1.0

= AV 0. But we have a problem of convenience with the ANSI description (ANSI PH3.49-1971). According to this description, SV 0 corresponds to a film speed of 3.125. I've adopted the practice used by many light meter manufacturers and adjusted the index so that a film speed of 100 corresponds to SV 0. This change forces an adjustment to the LV index as well so that the equation EV = LV + SV remains valid. All the tables in this book are based on SV 0 = ISO 100.

Light Meters and APEx

The exposure dial on most hand-held light meters is really just a circular slide rule. It adds and subtracts the APEx values for your convenience. Though hidden from view, a computer inside digital light meters does the number crunching.

Let's see what goes on inside a light meter from the APEx perspective. First you set the film speed on the calculator dial. Point the meter at the subject and make a reading of the luminance. When you dial-in the light reading, the calculator dial (or the internal computer) is actually adding SV and LV. By means of the dial or the display on the meter, you are given a range of f-stop and shutter speed combinations to choose from. This range of combinations corresponds to the first APEx formula, EV = AV + TV. Transfer your preferred settings to the camera, trip the shutter, and you will have delivered an exposure to the film specific to the area you read with the meter.

Most light meters have the option to give you the EV (exposure control value) directly. Repeating our earlier discussion, the exposure controls are comprised of the aperture and shutter speed. The intensity of the exposing light is moderated by the aperture. The duration of the exposing light is moderated by the shutter speed. The combination of these two controls is represented by the APEx term EV.

Some cameras have provision for setting the EV number directly on the lens. The camera locks the aperture and shutter together in reciprocal combination so all you have to do is choose the combination you like best. For example, many Hasselblad lenses and Rollie TLR cameras have this feature.

Light, the Scene and the Camera

This is as far as the traditional descriptions of the APEx system take you. In order for APEx to reach its potential, the system needs some additional terms. For example, photographic light meters do not read directly in LV units nor do they calculate the exposure delivered to the film. A photographic light meter will only display camera settings.

But this is no obstacle; there are simple ways to get really useful information from reflected light meters. Follow along as I show you how to extend the APEx system to greatly expand its usefulness.

We need to clarify some terms. The first term is illuminance. The light falling on an object is called illuminance. The principal properties of illuminance are intensity, direction, and color distribution.

The second term is luminance. A scene is the view encompassed by the film in the camera. Within any scene there will be objects that reflect light; and in some scenes there are objects that emit their own light. The light reflected or emitted toward the lens by objects in the scene is called luminance. For our purposes, it does not matter if the object is an emitter or reflector. What the camera "sees" when it is focused on a scene are luminances. In a sense, the camera lens gathers this pattern of luminance and forms a corresponding image on the film or focus screen.

The Exposure Effect of Luminance

The light from the scene gathered by the lens and imaged on the film actually <u>illuminates</u> the film. We use the term Illuminance Value (IV) to represent the intensity of the illuminance at the film plane. If you could stand inside the camera, you would see rays of light coming from the lens, illuminating the film with the projected image of the scene.

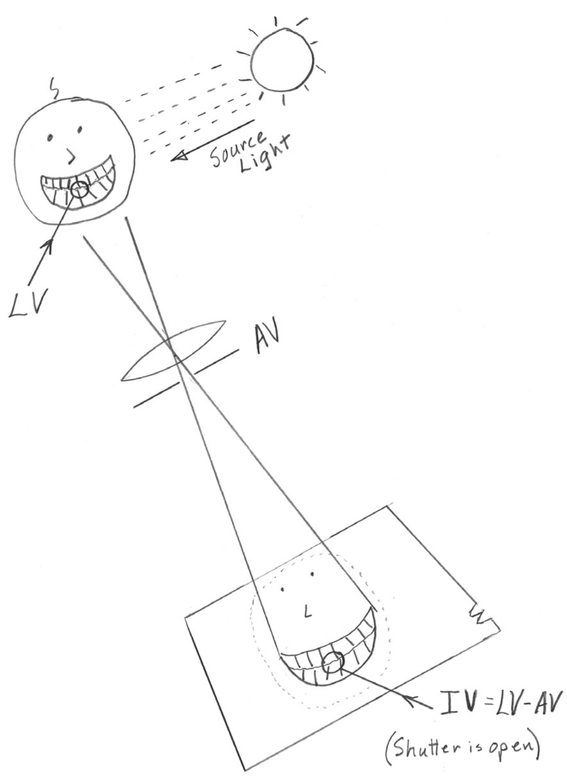
Proportional Intensity

Your intuition is rightly telling you that there must be a direct relationship between the luminance of an object in the scene and the illuminance it produces on the film. I call this property of optical systems proportional intensity. Proportional intensity assures that we can correlate the luminance of specific areas in the scene with the exposure the film will receive when we trip the shutter.

The Exposure Effect of Aperture

Varying the aperture of the lens controls the intensity of the image-forming light. The exact amount of light energy, illuminance value (IV), which actually falls on the film, is determined by the luminance (LV) of the subject and the light-gathering power of the lens (AV). The formula expressing this relationship is Illuminance Value equals the Luminance Value minus the Aperture Value.

IV = LV - AV



The Exposure Effect of Shutter Speed

Film receives illumination from the scene only while the shutter is open. The amount of time the shutter is open is called shutter speed. We use the term Time Value (TV) to represent the length of time the film is exposed to light.

Exposure occurs when film is subjected to light of a certain intensity (IV) for a period of time (TV). RV is the term I have chosen to represent the amount of exposure delivered to the film. (I would have liked to use EV, but it was already taken.)

The formula for this relationship is Exposure equals the Illuminance Value minus the Time Value.

RV = IV - TV

This is the APEx expression for the familiar formula: Exposure = Intensity x Time.

Stated another way, RV is the work done by the exposing light to change the photosensitive molecules of the film. In the camera, film gets its exposure from the combined effects of scene luminance, aperture and shutter speed. All these elements can be expressed in a single formula.

Note well: RV is not used in the same way that SV is used. RV refers to only one area in the scene. All photographs of real scenes will deliver a different RV to the film for every area that has a different LV. SV relates to capturing a statistically "average" scene in such a way that you will find the resulting print "acceptable". I'm not interested in acceptable. We will do much better.

The Combined Exposure Effect of Luminance, Aperture and Time

By substituting (LV - AV) for IV in the formula RV = IV - TV we get:

RV = LV - (AV + TV)

From our earlier discussion, we know that:

EV = AV + TV

Substituting EV for (AV + TV) in the equation RV = LV - (AV + TV) we get the exposure formula:

RV = LV - EV

If the desired exposure is known and the luminance has been measured, we can solve for the particular value, EV' (read "EV prime"). We get:

EV' = LV - RV

Here EV' represents the value of EV for a specific set of circumstances. EV' tells us the possible combinations of aperture and shutter speed settings to deliver the desired exposure (RV) to the film.

Using a Reflected-Light Meter to measure LV

The following discussion of film speed is important because it shows us an easy way to use our reflected-light meters to obtain the luminance value LV directly from the light meter's display.

SV is the APEx value associated with film speed. Film speed is a measure of how much exposure the film requires to result in the highest likelihood of a satisfactory photograph. Film speed is usually expressed as the ISO speed or as the term "Exposure Index."

From the APEx exposure formula we studied earlier, EV' = LV + SV, it is clear that if SV is zero, then EV' is simply equal to LV.

EV' = LV

Therefore the luminance of an area in a scene (LV) can be read directly from the EV readout of any reflected-light meter when the film speed is set to ISO 100 (SV = 0). This has important practical applications for picture taking and film testing.

If you look at the characteristic curve published by a film manufacturer, they often use the term "relative exposure" to label the X axis of the graph. What they are really specifying is RV. So now you have a meaningful number to put on the exposure axis.

With three pieces of information - the aperture, shutter speed, and luminance value (information you can easily record when you take a picture) - you can quickly calculate RV.

For example, I made a film test photograph. The luminance reading of one target area was LV 12. When I took the photograph, the camera settings were *f*/11 (AV 7) at 1/15 second (TV 4). To calculate the exposure the image of the target area imparted to the film, I used the formula RV = LV – (AV + TV). Substituting the values from above I got:

RV = 12 – (7 + 4)
<u>RV = 1</u>

With this handy tidbit, I can start building a very useful set of data. I can measure the density produced by RV = 1 for that degree of development. We will exploit this fully in chapters to follow.

The Important Formulas

EV = AV + TV

EV' = LV - RV

RV = LV - EV'

RV = LV - (AV + TV)

LV = EV' (when SV = 0)

EV' = LV + SV (for ordinary photography)

Using APEx to Account for Filter Factor and Lens Extension

MV is the APEx value associated with exposure compensation for image magnification. MV is negligible for lens-to-subject distances greater than eight times the focal length of the lens.

For example, I made a close-up photo with a 210 mm lens. The lens was 420 mm from the film plane. According to the usual calculations, the compensation factor calls for multiplying the exposure time by 4. In APEx usage, a factor of 4 is MV 2. From the Iso-density Graph I knew I needed a RV of -3 to get the print density I desired. The area I read with the meter gave me a luminance reading of LV 10.0. So I applied the formula EV' = LV - RV - MV to arrive at the correct settings.

EV' = 10.0 -(-3) - 2 = 11.0.

I wanted to keep the depth of field shallow, so I chose to set the lens at *f*/8. The AV for *f*/8 is 6; so to get the shutter speed I subtracted AV 6 from EV 11 and got TV 5 (TV = EV' - AV). TV 5 is the shutter speed 1/30 second. I set the lens to *f*/8 and the shutter to 1/30 second and made a perfect exposure.

Filter Factors and APEx

FV is the APEx value associated with exposure compensation for filtration. For neutral density filters, each 0.3 density equals one FV unit. For example, a ND filter with a density of 0.6 would have an FV of 2.0. When using colored filters, the FV is best determined by test using the manufacturer's recommendation as a starting point. Because the FV is dependent upon the spectral response of both the particular filter and the film, you must run your own test to obtain a precise value for FV.

The Extended APEx Formula

EV' = LV - RV - MV - FV

Recap

Standard Terminology	APEx Term
Relative Aperture (*f* stop)	AV
Shutter Speed (in seconds)	TV
Film Speed (ISO or exposure index)	SV
Luminance	LV
Exposure Control Value	EV
Illuminance	IV
Exposure	RV
Filter Factor	FV
Magnification Factor (bellows factor)	MV

Chapter 8 The Sensitivity of Film and Degree of Development

Sensitivity and Development

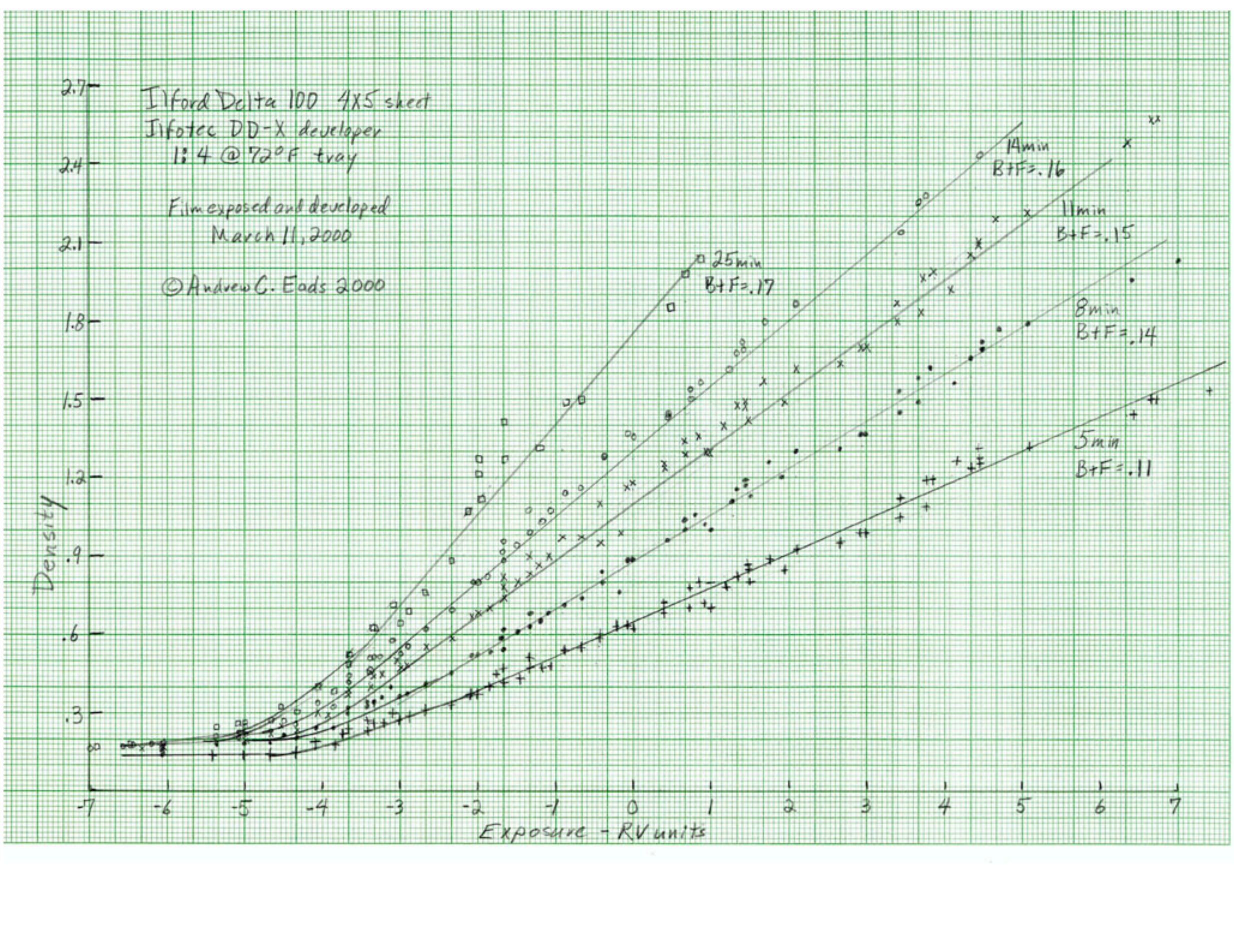
Does the sensitivity of film change with different degrees of development? Yes! To find out just how much, we need a new way to visualize the performance of photosensitive materials. To accomplish this I developed a tool called the iso-density graph. The iso-density graph provides the basis for the system of exposure/development control system I have named VIDEC: Visually Integrated Development and Exposure Control.

Let us review the basics. The response of photographic film or paper to exposure is *optical density*, the measure of how much light is absorbed by the processed photographic film or paper.

Sensitivity is the measure of how much exposure is needed to obtain a specified optical density at a specific degree of development. For example, one film may require 4 times more exposure than another film to obtain a particular density.

Degree of development is the effect on film caused by the action of developer. If you establish a set of development conditions as a baseline, then varying any element of that set changes the degree of development. The factors that interest pictorial photographers are development time, developer temperature, concentration, and agitation. If any of these factors are increased or decreased, then the degree of development increases or decreases.

The classic way to characterize a photographic material is the *H&D curve*. Many of you have tested you own films in this way. Recently, I characterized Ilford Delta 100 4x5 sheet film in Ilford DD-X developer. I photographed a test target that gave me



a wide range of exposures on each sheet of film. I carefully recorded readings and settings. Exposing five sets of negatives, I processed each at a different time (holding all other variables constant.) After developing the film, I measured the density of each target patch. Using this data, I created a data table that correlated the exposure[1] each target area received with the resulting density for each development time.

Then I plotted the data from this table. The result is the *family* of H&D curves for this film/developer combination. This family of H&D curves is specific to my agitation technique, my thermometer, my light meter, my shutter, etc. By maintaining a consistent technique, I can repeat these results each time I run the test or use the film.

But now, back to the original question. Does the sensitivity of film change as the degree of development changes? Yes! By using information hidden in the H&D curves, we can create this new representation of film performance called the iso-density graph.

Setting the Baseline

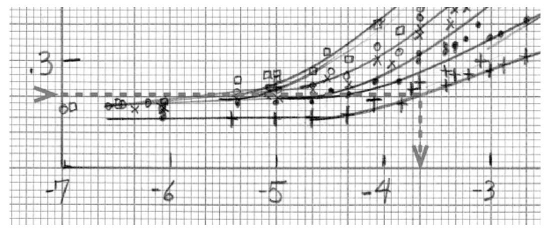
An important goal when calculating exposure is to get just enough exposure to record detail in the darkest important area of the scene. One authority[2] describes the rationale for a minimum effective printing density (EPD) aim point of 0.10 plus the gross fog (the sum of the film's base density and the density caused by the random development of unexposed photo-sensitive molecules). I use this value throughout this book. There are reasons why you might choose a different aim point but they are beyond the scope of this book.

Development Time	Gross Fog	Minimum EPD	Aim Point Negative Density
5	0.11	0.10	0.21
8	0.14	0.10	0.24
11	0.15	0.10	0.25
14	0.16	0.10	0.26
25	0.17	0.10	0.27

Table 1 – Neg. density at Dev. time x to yield EPD 0.10

Using 0.10 plus the gross fog as the aim point, I made a table (Table 1) to show the density needed for each development time. From my test data, the gross fog was 0.11, 0.14, 0.15, 0.16 and 0.17 for the 5, 8, 11, 14 and 25 minute development times respectively.

Table 2 is created from the H&D curves for this film. It shows how much exposure is required to achieve the shadow density at each development time.



Starting with the 5-minute curve, I found the density 0.21 on the density axis of the graph and read across the graph to the corresponding point on the curve. Reading down from that point, I determined that the exposure for that density was –3.6 RV units. I recorded this result on the iso-density table. I repeated these steps for all five development times.

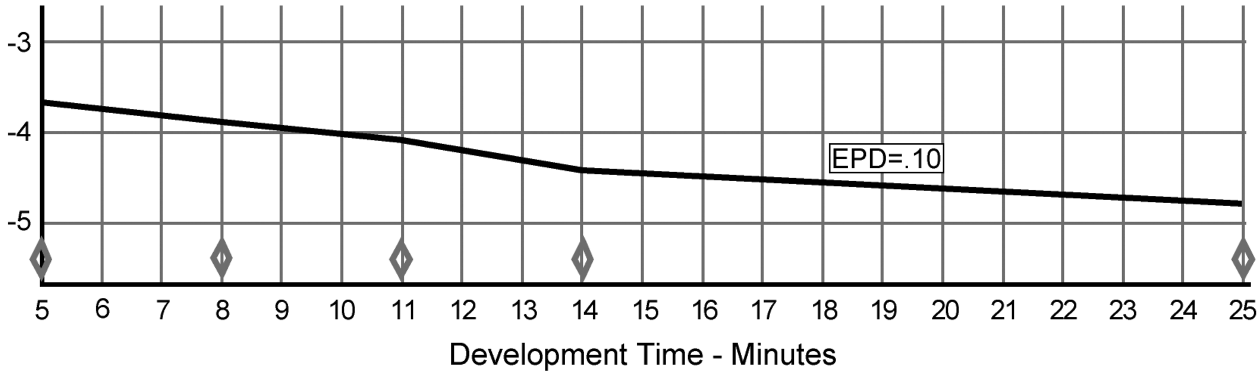
Development Time	Aim Point Negative Density	Exposure (RV units)
5	0.21	-3.6
8	0.24	-3.8
11	0.25	-4.1
14	0.26	-4.3
25	0.27	-4.6

Table 2 – Exposure required to obtain minimum density at each development time

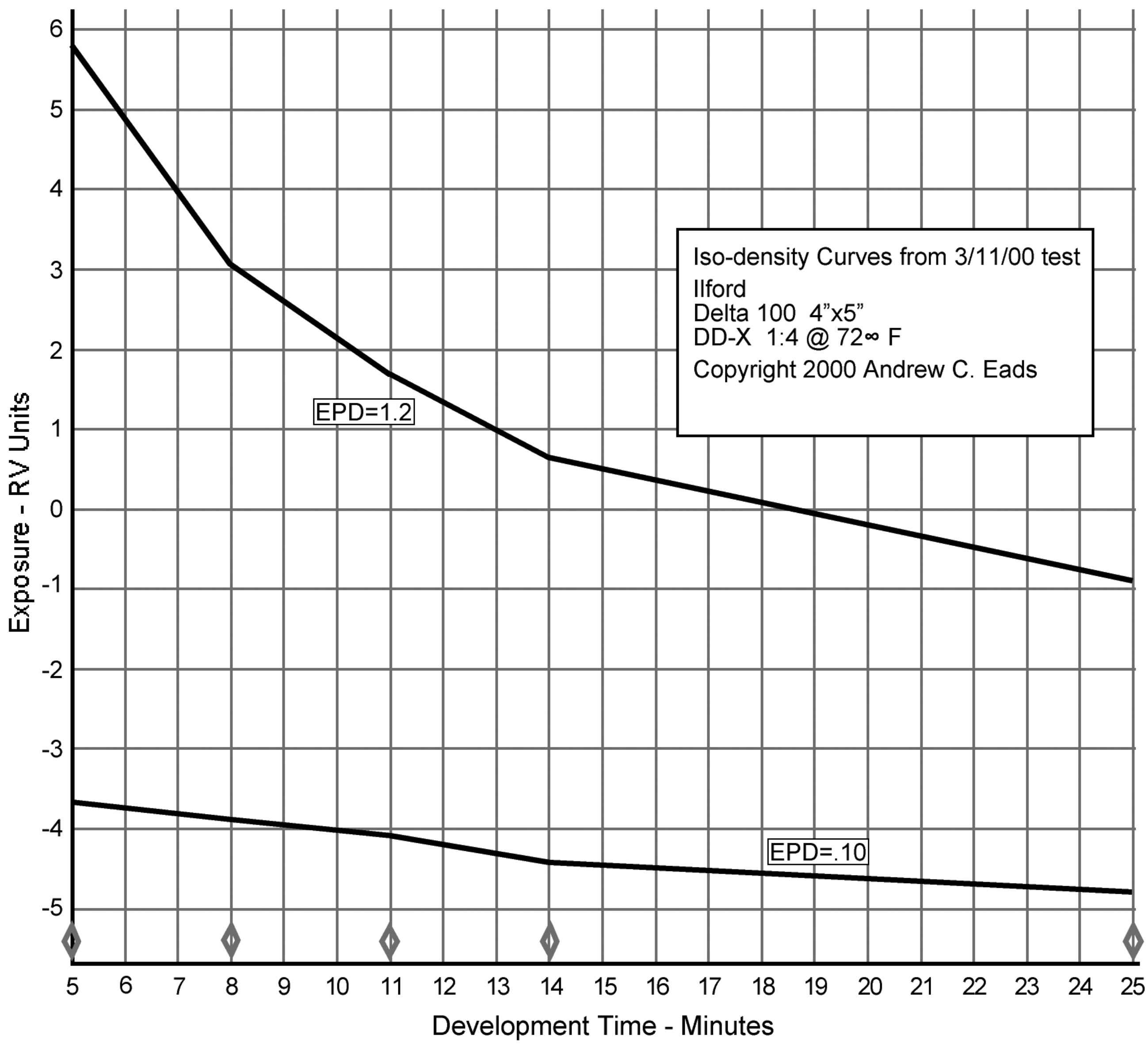
From the data in Table 2, we can make an iso-density graph. Since all of the densities represent the same effective printing density (EPD) of 0.10, we will call the plot of this data an *iso-density curve*. The prefix *iso* is used here in the same way that an iso-bar defines a single pressure on a weather map or the way that a contour line on a topographic map represents a specific altitude.

The plot of this curve shows that there is a slight change in the sensitivity of the film over this wide range of development times. Nothing terribly exciting here; the sensitivity of the film increased by just 2 times. But something very remarkable happens at higher densities.

A useful higher density to explore with an iso-



density curve is defined by the printing paper you use (see Chapter 10 - The Printing System Test). For example, the #2 contrast-grade paper I like to use has an effective printing density range of 1.20, that is, a density range that prints just a noticeable shade of gray lighter than maximum black to a shade of gray just darker than paper-base white. I applied the iso-density technique to a printing density that



is representative of the lightest tones perceptible on this print paper. The method for making this table (Table 3) is like the first. I added the gross fog density and the highlight density (EPD 1.2) to obtain the maximum density.

Dev. Time	Gross Fog+0.10 EPD	Max. EPD	Negative density
5	0.21	1.20	1.41
8	0.24	1.20	1.44
11	0.25	1.20	1.45
14	0.26	1.20	1.46
25	0.27	1.20	1.47

TABLE 3 - #2 CONTRAST-GRADE HIGHLIGHT EPD

Repeating the steps to make the iso-density table (Table 4) we get:

Development time	Negative density	Exposure (RV units)
5	1.41	5.7
8	1.44	3.1
11	1.45	1.7
14	1.46	0.7
25	1.47	-0.8

TABLE 4 - EXPOSURE REQUIRED TO OBTAIN HIGHLIGHT DENSITY AT EACH DEVELOPMENT TIME

I plotted this data on the iso-density graph with the first curve.

The first time I plotted an iso-density graph, I was amazed at the radical change in sensitivity at high densities. It takes over 90 times more exposure (6.5 stops) to get an EPD of 1.20 at 5 minutes development time than it does at 25 minutes!

This wide variation is the very reason we can expand and contract the density range of a negative by changing the degree of development. Now, with the iso-density graph, we have the means to visualize the change. Not only does the sensitivity change with the degree of development, the higher the desired density, the greater the change is.

By finding the exposure difference between the two curves you will have an accurate measure of the scene luminance range that can be captured for that particular combination of print paper and film development time.

There are some exciting implications too. In the next chapter, we will explore the use of two new tools, the LV ruler and the Step Tablet Print. These tools, in combination with the iso-density graph, are the VIDEC system's distinctive elements. With it we will couple the measured luminances in a scene to any shade of gray on a tested photographic paper while simultaneously calculating the optimum exposure and development time.

(Endnotes)

[1] Photo Techniques magazine JAN/FEB 2000, Vol. 21, No. 1, Simplifying and Understanding Photographic Exposure With The APEx System

[2] The Theory of the Photographic Process, Revised Edition 1954, C. E. Kenneth Mees, D.Sc., F.R.S., Chapter 22

Chapter 9 The Iso-Density Graph

Introduction

When faced with the wide range of contrasts found in everyday scenes, photographers have continually sought some means to evaluate the scene, anticipate the outcome and determine the optimum exposure and degree of development. A good negative means time can be spent refining the print's impact rather than struggling to salvage the image.

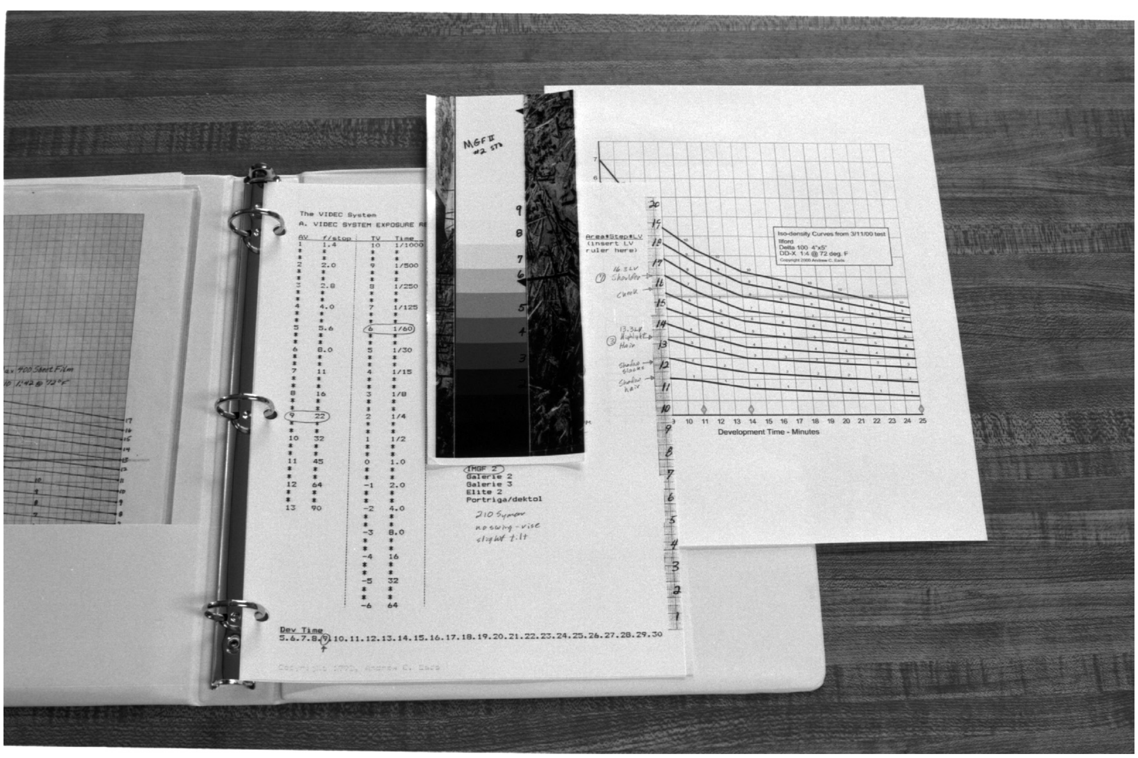
Many photographers use visual aids to relate the lights and darks they perceive in a scene to the shades of gray in a print. The 10 zones of the Fred Archer/Ansel Adams Zone System are an example. Perhaps you have seen a gray-scale fastened to a light meter used by a Zone System practitioner who, by some calculation, arrives at an exposure and development solution.

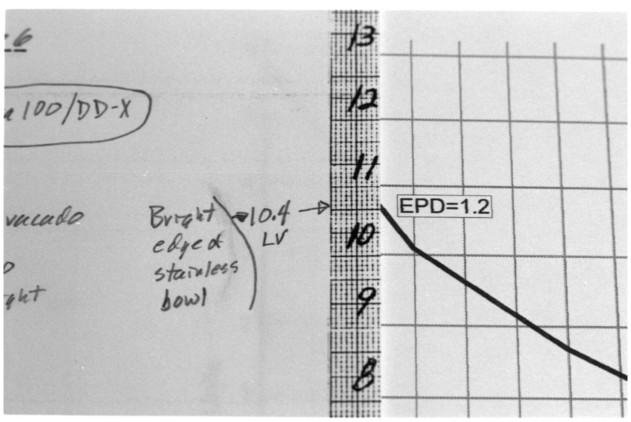
In this section, we will examine a different path to achieving optimum exposure and development. I call this system VIDEC for "visually integrated exposure and development control." The three tools unique to this system are the iso-density graph; the LV ruler and the step tablet print (STP). We will examine each in turn.

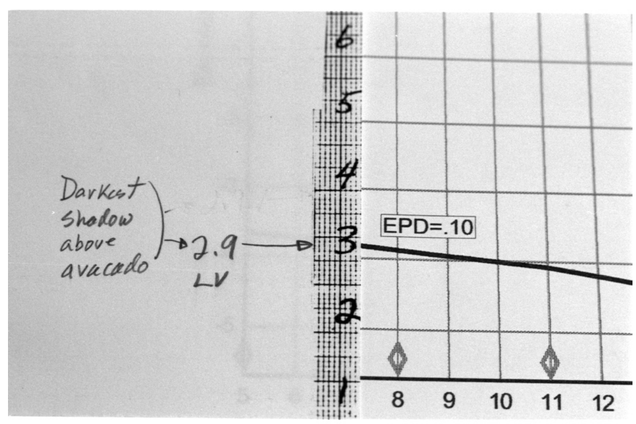
As we learned in the previous chapter, the iso-density graph relates a particular effective printing density (EPD) to a range of exposure and development combinations. Two iso-density curves based on the effective printing density range for a particular print paper were plotted—one for the EPD that prints just a shade lighter than maximum black, the other for the EPD that prints just a shade darker than paper-base white.

The LV Ruler

The LV Ruler is nothing more than a piece of paper with a scale on one edge drawn to the same







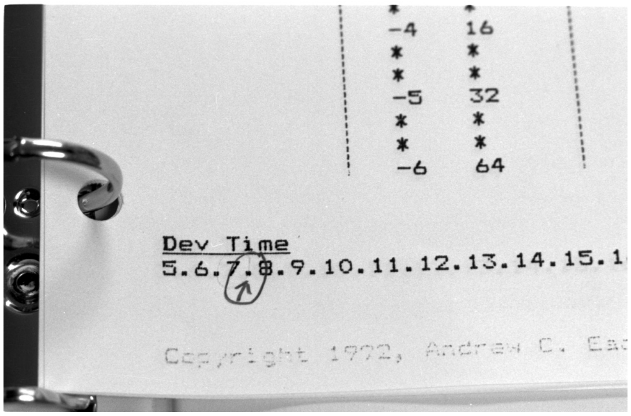
size as the RV (exposure) scale on the iso-density graph. LV stands for Luminance Value; the intensity of light in an area of the scene as measured with a spot meter from the camera position. It is marked off in units from 0 to 17, the range of scene luminances that you are likely to encounter. For convenience, I copy the LV Ruler onto the right edge of my exposure record sheets.

Using the Iso-Density Graph

We can use the two-curve iso-density graph in combination with the LV Ruler to accurately determine both optimum exposure and development time. The bowl arrangement contains an area I wanted to be a near white tone and one I wanted to be near black. I marked the two light meter readings on the LV Ruler. I then positioned it on the iso-density graph so the high reading touched the top curve and the low reading touched the bottom curve. There was only one place where the marks on the LV Ruler touched both curves.

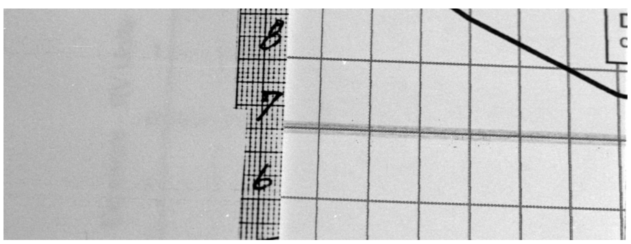
I followed the LV Ruler's edge to the development time axis to read the development time. Because the ruler was a little over the 7 minute mark, I rounded up, recording 7.5 minutes on the exposure record sheet.

The LV ruler and iso-density graph work to-



gether just like a slide rule to obtain the EV number for the shutter speed and aperture settings. The RV=0 line points to the result we want (EV) on the movable scale, the LV Ruler.

To make it easy to find, I highlight the RV=0 line with a colored pencil. In this case, the RV=0



line pointed to 6 2/3 on the LV ruler, which I recorded on the exposure record sheet as the EV number for the camera settings.

Setting the Camera Controls

Since I did not use a filter, the filter factor (FV) is 0. However, I was close enough to require additional exposure to compensate for image magnification. I needed 2/3 *f*/stop so the magnification value, MV, is 2/3. Subtracting 2/3 from 6 2/3, gave me an effective EV of 6.

I wanted substantial depth of field so I chose *f*/32 and circled AV 10 on the sheet. Using the formula, EV=AV + TV, I decided on a TV of –4, or 16 seconds exposure time. The calculated exposure settings were *f*/32 at 16 seconds; however, 16 seconds is long enough to depart from the reciprocity rule. The film's data sheet indicated the exposure time had to be doubled to achieve equivalent exposure. Actual exposure was *f*/32 at 32 seconds. The

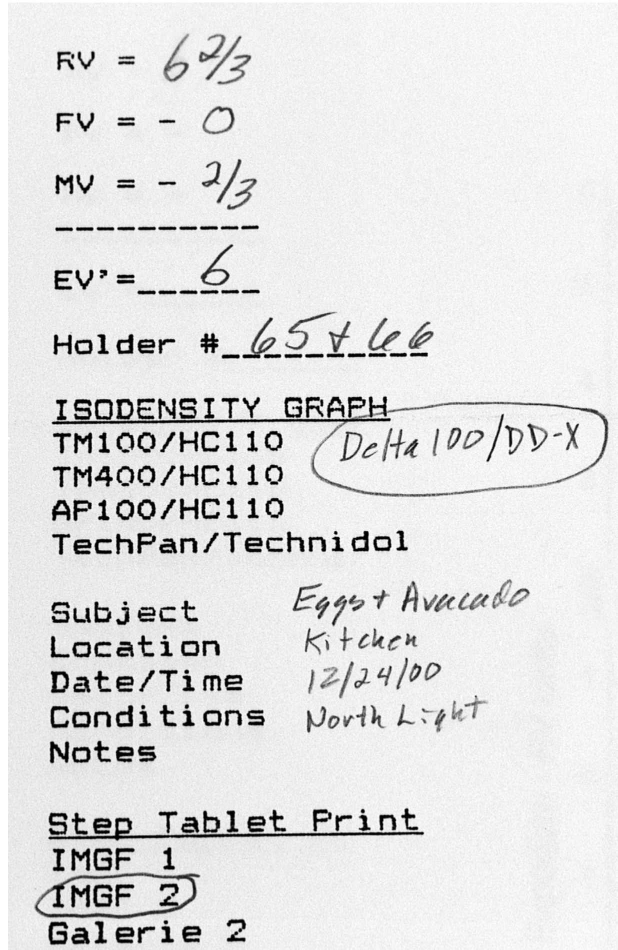
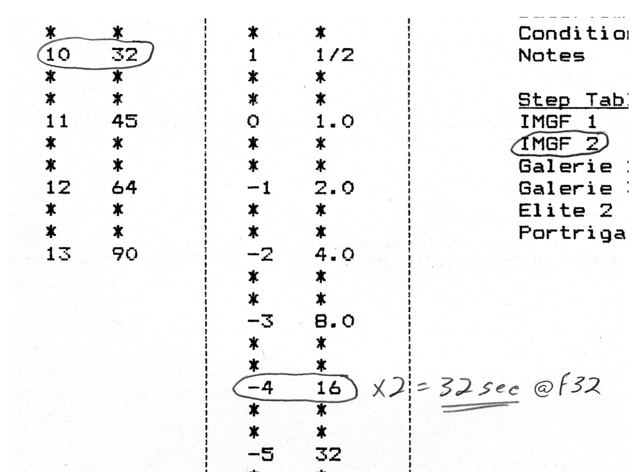


photo on the opposite page is a straight print on #2 grade paper.

As this example illustrates, the two-curve isodensity graph works but only for those few situations where the important tonalities are near white and near black. This won't work if you decide to



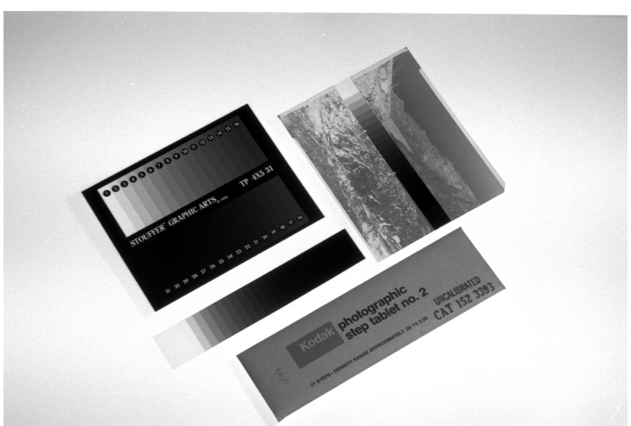
interpret a scene in low-key with no value remotely approaching white. Or you may render a scene in high key, or you may want to exaggerate a subject's contrast. By expanding the iso-density graph, we can solve these problems.

The "Populated" Iso-Density Graph

How can we make the iso-density graph useful for the intermediate shades of gray, and how can we make one iso-density graph useful for any photo paper? The solution is to create an iso-density graph with intermediate curves. This begs a question: What is the rationale for picking the set of EPDs to plot these curves?

The Step Tablet Negative

The answer lies in a special negative that photographers have used for decades—the step tablet negative (STN), which is composed of areas or steps of increasing density. Stouffer Graphic Arts sells step tablet negatives in convenient sizes and in increments of both 0.15 and 0.10. I also use a Kodak #2 Step Tablet Negative with a density difference of 0.15 between each step.

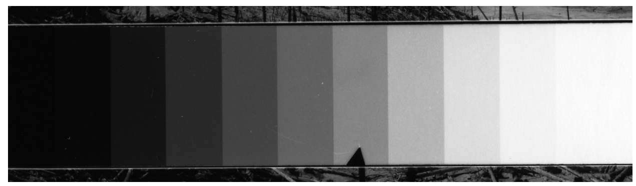


The Step Tablet Print

The STN can be printed like any other negative. I call a print from an STN a Step Tablet Print (STP). Because each regularly spaced density increment is known, the STP becomes a portable record of the tonal values that result from this set of known EPDs. The STP is unique to each paper; its appearance is dependent on the contrast, curve shape, tone and development conditions.

I print the STN so that the second density increment prints just a shade lighter than maximum black. I assign the number "1" to that area. Each lighter shade is numbered in sequence (see Chapter 11).

Because the STP shows which EPD produces a



certain tonal value and the iso-density graph shows what exposure produces that EPD for any tested degree of development, there is a direct pathway from the light meter reading to the first print. It is as though the negative was not part of the process; we see through the intermediate of the negative to the print. At the same time, this properly exposed and developed negative provides ample opportunity for a different interpretation when printed.

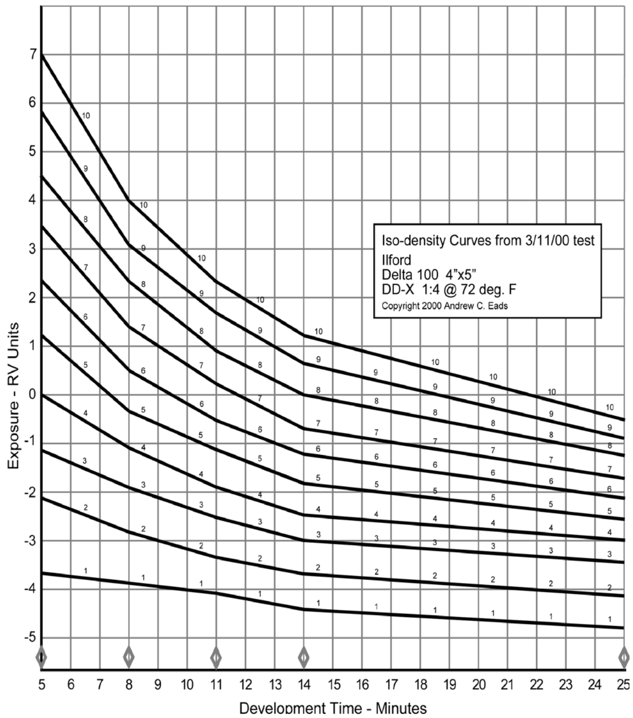
Drawing the Iso-Density Graph

To draw the iso-density graph, choose effective printing densities that correspond to the density increments of your step tablet negative. With a step tablet negative increment of 0.15 density units, plot each curve according to the following pattern:

1st (Base Curve) EPD = 0.10 + gross fog;
2nd Curve EPD = 0.10 + gross fog + 0.15;
3rd Curve EPD = 0.10 + gross fog + 0.30;
4th Curve EPD = 0.10 + gross fog + 0.45.

Repeat this pattern for each subsequent curve. The film test data determines how many curves you can produce. I plan my tests to produce enough density data for 10 curves (EPD range = 1.5). The complete test procedure is found in Chapter 11

The iso-density graph for Ilford Delta 100 developed in DD-X is shown below. It has iso-density curves at 0.15 density intervals corresponding to my STN and its STP.



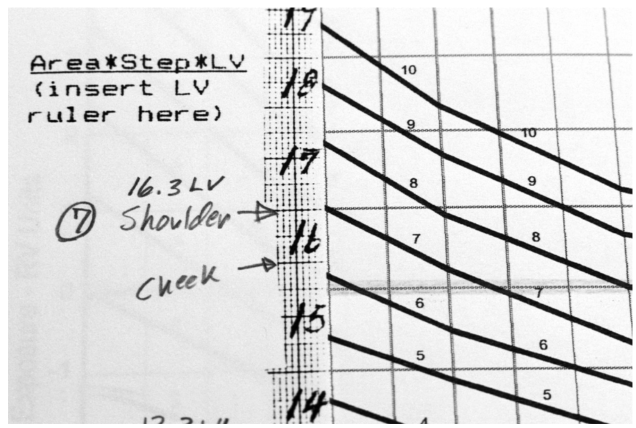
Using the Populated Iso-Density Graph

Let's see how the fully populated iso-density graph, step tablet print and LV Ruler worked together to make a portrait of my friend, Lisa.

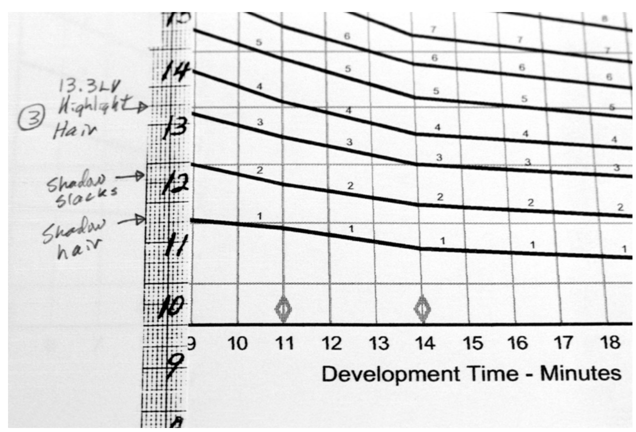
These are the steps I followed:

1) Analyze the scene with the spot meter and record the LV readings of several visually important areas onto the exposure record sheet. Her shoulder read 16.3 LV; her cheek 15.6 LV; the highlight on her hair 13.3 LV; the shadow side of her slacks 12.2 LV; the deepest shadow on her hair 11.4 LV.

2) Choose one important dark value and one important light value. Using the STP for the paper you plan to print on, assign a shade of gray to these two areas. Mark the LV Ruler with the chosen step number adjacent to the LV reading for each of the two areas. I chose to render her shoulder as Step 7 from my STP for Ilford Multigrade-fiber base,



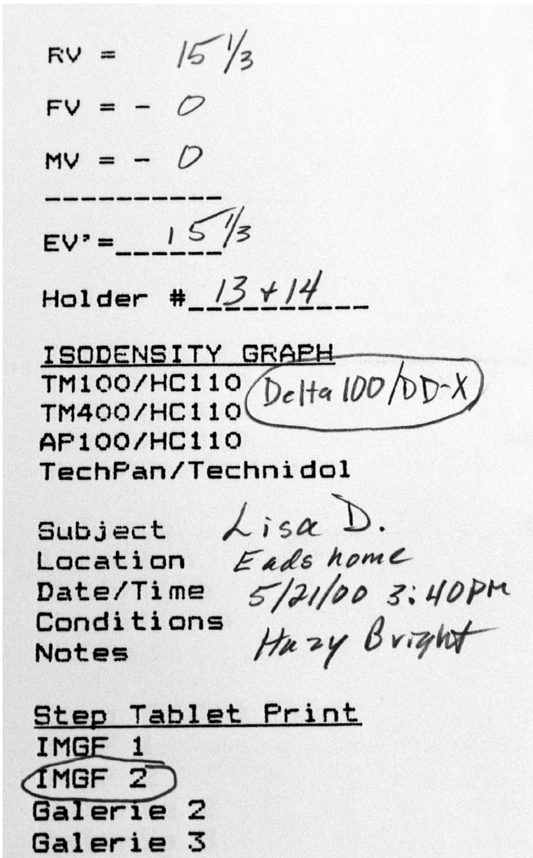
grade 2. I chose to render the highlight on her hair as Step 3.



3) Juxtapose the LV Ruler over the iso-density graph so that the two STP step numbers on the LV Ruler touch the corresponding iso-density curves on the graph. Read the EV number (where the RV = 0 line touches the LV Ruler), in this case 15 1/3. Now

read the development time, in this case 9 minutes. Record the results.

4) Convert the EV number to a shutter speed and *f*/stop combination. Don't forget to account for filtration, magnification and reciprocity departure.


RV = 15 1/3
FV = - 0
MV = - 0

EV'= 15 1/3
Holder # 13 + 14

ISODENSITY GRAPH
TM100/HC110 Delta 100/DD-X
TM400/HC110
AP100/HC110
TechPan/Technidol

Subject Lisa D.
Location Eads home
Date/Time 5/21/00 3:40PM
Conditions
Notes Hazy Bright

Step Tablet Print
IMGF 1
IMGF 2
Galerie 2
Galerie 3

In this case there were no corrections needed so I chose the settings 1/60 second at *f*/25.

All there is to do at this point is to take the exposure, process and print. The photos of Lisa are straight enlargements on the same paper used to make the STP.

Some Observations

Only two scene areas and their assigned shades of gray can be used to calculate exposure and development. But with VIDEC you can choose <u>any</u> pair. Once the pair is chosen, it is easy to see the shade of gray for any other metered area in the scene by observing which iso-density graph curve it falls on and looking at the corresponding shade of gray on the STP.

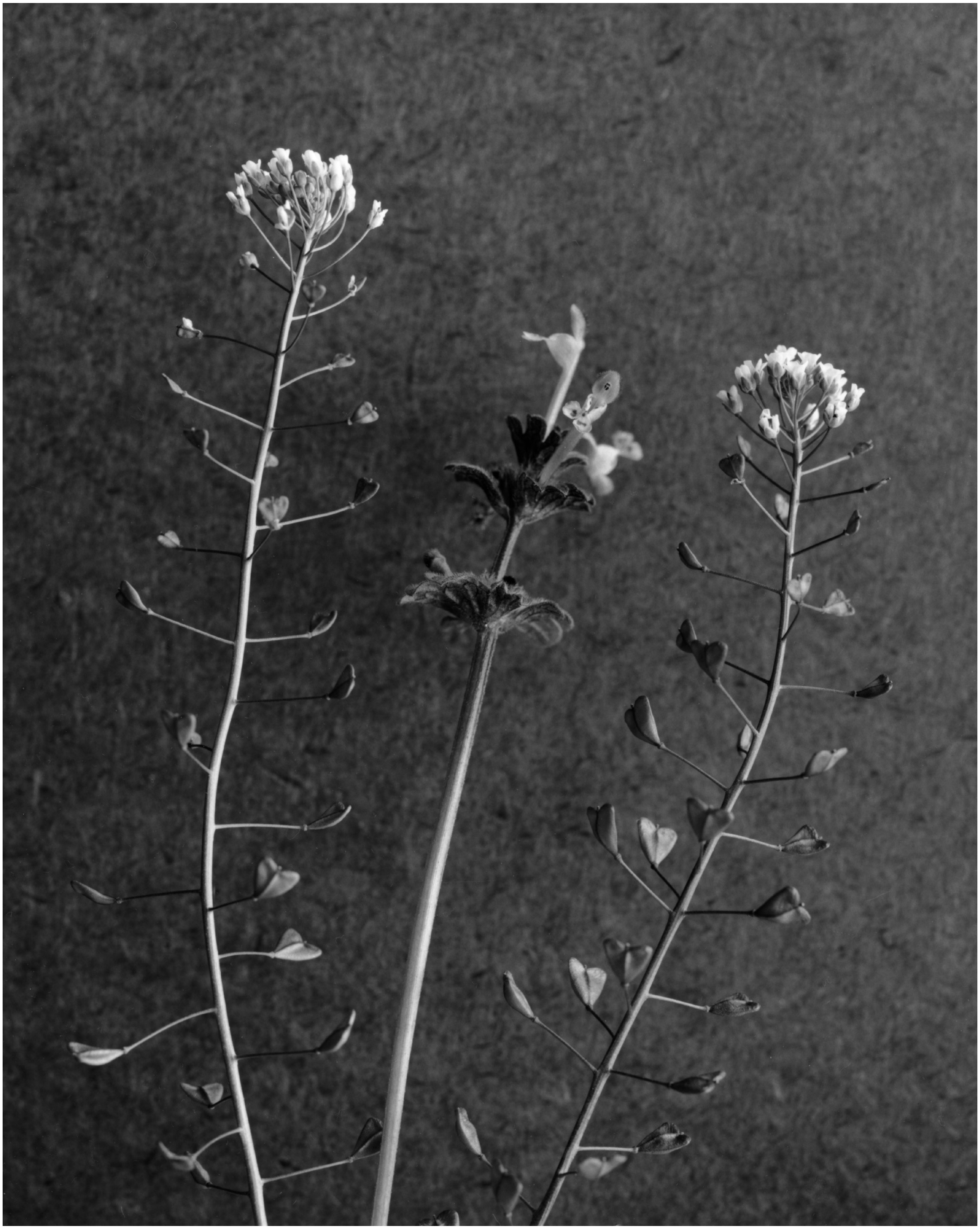
You can use VIDEC techniques to anticipate the tonal effects of lighting choices when setting up a controlled lighting situation. For example, if you set up a portrait, you can adjust the background light and know what shade of gray it will print.

VIDEC is ideal for sheet film users. However, roll film users can take advantage of its many benefits, as well. I keep a fine old Rolliecord TLR (120 roll film) with me when I run errands. I have found that most of the subjects I like to photograph fall close to the 10 minute development time. When I come upon a scene with higher or lower contrast than my "normal", the iso-density graph shows me that I will need to use a higher or lower contrast grade for that exposure. Significantly, with the iso-density graph I know I am exposing so I <u>never</u> lose desired shadow detail.

In the VIDEC system, film speed is nowhere to be found. Film speed is a statistically based number that aims to deliver the highest likelihood of an acceptable result when processing conditions are fixed. As we have seen conclusively, the sensitivity of film changes as the degree of development changes. This renders the conventional use of film speed useless to anyone who manipulates the degree of development.

In place of film speed, the iso-density graph reveals the <u>sensitivity</u> of your chosen film for any tested development time. This is a fundamental difference between VIDEC and other systems. The VIDEC method accounts for your intention for the photograph, the conditions of the scene, and the performance of your film and paper systems. VIDEC delivers control, precision and flexibility for outstanding results.

Chapter 9



Chapter 10
The Printing System Test

The Step Tablet Print

The Step Tablet Print (STP) is a portable, visual record of the shades of gray a photographic paper will produce. It is a photographic print of a Step Tablet Negative made in your enlarger on the paper(s) you use to print your images.

Each STP step is the visual rendition of a specific negative density when printed under standardized conditions.

It accounts for your enlarger light source, the flare of your enlarging lens, and your developing habits and conditions. This is important because negatives you make with VIDEC using your STP are truly optimized for all the important variables.

You can make a STP for all of the papers you like to use. To keep it simple for now, make your first STP on just one paper. Use the normal contrast grade for this paper even if you are accustomed to using a higher or lower grade. If you use a variable contrast (multi-grade) paper, use the #2 filter.

If you are using a classic process such as platinum or cyanotype simply prepare your print medium in the usual way. Make a STP as described below.

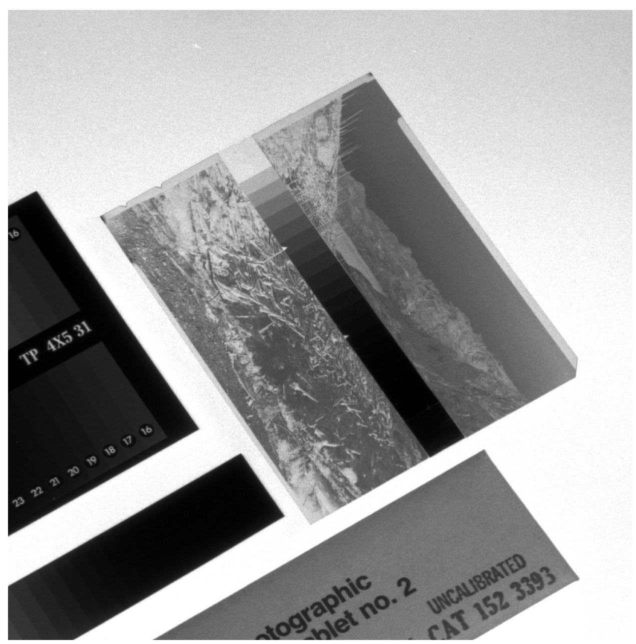
You will need one special item, a Step Tablet Negative. A step tablet is a negative with carefully exposed areas on it called steps. My tests were conducted using a "Kodak Photographic Step Tablet No. 2 Uncalibrated." The densities of each step increase uniformly from one to the next by 0.15 density units.

Print Exposure Range

If you print a Step Tablet Negative so that the step with density 0.15 printed as just-lighter-than-maximum-black, then you can make a correlation between negative density and the resulting print density (i.e., shade of gray).

A count of the steps that are visibly different shades of gray is a measure of the contrast range of that particular print paper and developer combination. High contrast paper will print fewer density steps to achieve the range from black to white than a normal grade of paper. Low contrast paper will print more density steps to achieve the range.

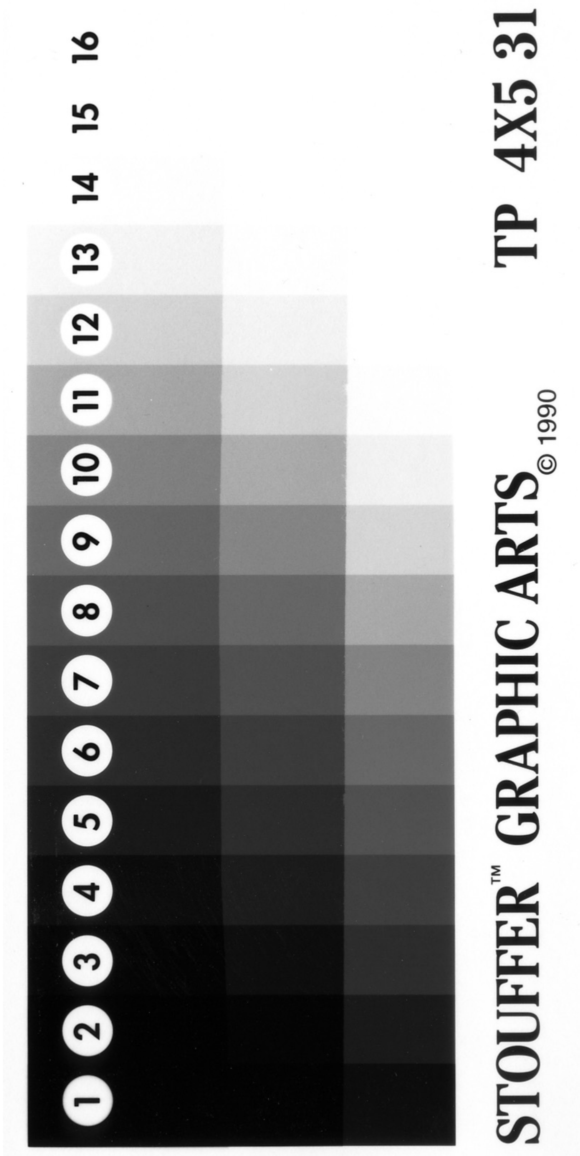
If, for example, you now double the exposure and make another print of the step tablet negative, the number of steps visible should be the same as the prior test. The obvious difference is that the first step that appears just lighter than maximum black begins two steps further up the tablet.



So now we have a print that shows us just what shade of gray we will get on a print when the density difference between steps is a known quantity. In our illustration, the interval between density steps on the step tablet negative is 0.15 optical density units. One brand of "normal" grade paper may print with a density range of 1.2 while another brand of "normal" grade may print with a range of 1.05. It does not matter using the VIDEC system that there are differences. The goal of printing a step tablet print is to characterize your print paper under your printing conditions.

Making the Step Tablet Print

Put a Step Tablet Negative into the enlarger or contact print frame.



Make a test strip of the Step Tablet Negative in your usual fashion. The goal is to have the second step of the Step Tablet Negative print just a shade lighter than pure black. This shade of near black is our visual anchor point. It is important to get this right.

I judge the middle exposure on the STP test print above to be the best choice. This step tablet is incremented in 0.10 density units.

Judging the Base Step

The task at hand is to judge the test print you just made. This seems simple enough, just follow the instructions in the previous paragraph. However, when your eyes have adjusted for darkroom lighting conditions, you may have trouble accurately judging the base step. Here are some suggestions to avoid the common pitfalls.

Turn on the lights in your darkroom as soon as the first test is fixed. Allow your eyes to adjust to the light for at least 2 minutes before you try to judge the image. Spend that time looking around the room at a variety of objects so that your eyes adjust to the brighter light and contrast.

Judge the STP in normal room light. Do not judge it under very bright light. Bright light will distort the appearance of the prints you make. The only exception to this caveat is if you know that the specific print will be displayed under the same lighting conditions and never under less light.

There is another phenomena commonly known as "dry-down" that affects the ability to judge the Step Tablet Print test. Photo papers tend to look darker when they are dry than when they are wet. My observations show that dry-down may be the combination of visual adaptation lag to normal room lighting and the amount of water held on the surface of the print.

The tones in a print appear lighter when the print surface is wet than when the water has been removed. When evaluating a print, I squeegee the water off the print while I am waiting for my eyes to adjust to the light. Because the fibers in a wet print are more translucent than a dry print, the color of the tray you use to hold it may affect the perception of brightness and contrast. I use white trays.

Some Tips

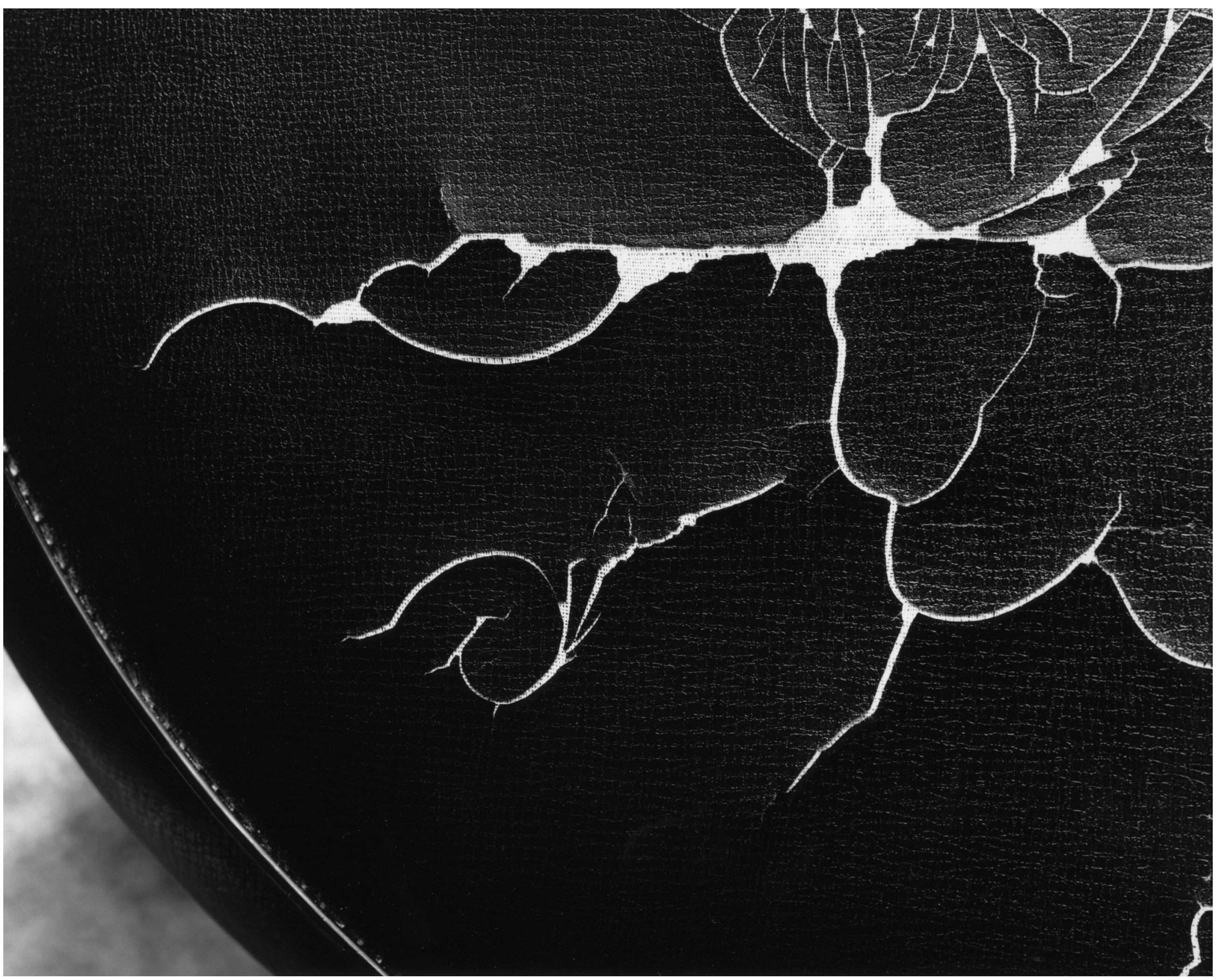
If you enlarge your negatives, the STN prints most accurately when it is part of a normal negative simulating your enlarger's flare conditions. To do this, I first cut the STN in half lengthwise (wear gloves). Take one of the halves and store it in its package. Take the other half and lay it on a negative of normal contrast and density range. I spliced mine into a 4x5 negative (it was an extra that was discarded because of some nasty dust spots). Cut out a section of the negative as wide as the STN and tape it carefully with the absolute bare minimum amount of tape into the split negative. See the illustration on page 47.

Using the exposure you just determined, make a print of the Step Tablet Negative. While the darkroom is set up, make some extra STPs under the identical conditions. Be sure to mark them so you won't confuse them with any other papers you may use.

Now with your own Step Tablet Print in hand, repeat the exercise from Chapter 2, "An Exercise For The Visual Sense".

Checklist for Success

- Paper developer and other chemicals are fresh
- Enlarger lens is clean and enlarger is aligned
- Lamp house is clean
- You have tested your safelight to be sure it is safe
- Exposure and development are timed accurately
- Make extra STPs - one for each camera bag plus a spare or two.



Chapter 11 Testing the Film + Developer + Camera System

Purpose and goal of the tests

The end goal is to have a field-usable iso-density graph that will cover a wide variety of picture taking situations. The film test data will be used to generate the H&D curves for the chosen film/developer combination. From the H&D curves, we will derive the data needed to draw the iso-density curves. Of course, we want to do this at the lowest cost in time and materials. Here are the major considerations.

- A good record keeping system so all that hard-earned data will be useful to you
- Enough density measurements to make a smooth curve
- A practical range of development times
- The RV range must include the film's threshold sensitivity for each development time.
- Enough curves (individual development times spaced well) to make a good iso-density graph
- A wide RV range so the curves will give enough data for the iso-density graph.

If you have never conducted a film test like this before, then I suggest you perform the baseline test before you perform the full test. This bite-sized test is designed to help you work out the procedure. Any mistakes made at this stage are much less expensive in time and materials than the full test.

It may be helpful to think of the test procedure as building a chain of information. Each link in the chain leads to the next until you have a finished iso-density graph.

I've designed some record sheets you may find useful. Feel free to use them or design your own.

> The method used here generates the test exposures in-camera. Other authors describe methods using step tablet negatives or sensitometers to expose the film. I prefer in-camera because it accounts for lens transmission, flare from all sources and processing technique.

The Baseline Test

The baseline test will take you through to one curve of a five curve H&D graph. This section is very detailed so be sure to read it carefully. It ends at the section "The Multi-Area Target Test."

There are two ways to get enough different exposures to make a decent H&D graph: the single-area target method and the multi-area target method. In both cases, you use your camera to deliver known exposures to the film. The baseline test is written as if you are using the single area target procedure.

The target serves two purposes; it provides the easy-to-measure exposing light and it provides an easy-to-read density patch on the negative. A single target is simply a uniform surface, evenly lit. This is perfect for 135 size cameras with 24 exposure rolls. To get enough exposures, you simply aim the camera at the target and vary the camera settings in small (usually ½ stop) increments. Using the exposure plan from my worksheet, the exposure range possible is 12 RV units in intervals spaced for optimum results.

You large-format users are jumping out of your seats about now thinking how expensive the single area target test will be in materials and, worse, darkroom time. This is where the second method comes into play, the multi-area target. The multi-area target will reduce the sheets of film needed to not more than 4 per development time. If you do everything perfectly right the first time you will use about 24 sheets of film; a modest investment considering the quality results you will enjoy well into the future. My original tests with Kodak T Max 100 and 400 sheet films were good for 16 years of picture making before there was a change to the film.

Do you remember how much money you spent on your best lens? One reason it cost so much is because it makes a fine image of every area in the scene with near perfect correlation between scene luminance and exposure intensity (see Proportional Intensity, Chapter 7). We will exploit those qualities with the multi-area target. I will first show how the single target test works; the multi-area target test is a simple extension of this method.

In both cases, the first worksheet is the Film Test Checklist. There are sample worksheets in the Appendix and blanks in the Worksheet section.

Using the Worksheets

Don't skip any steps here. I know, it takes much longer to fill out the worksheets than it does to make the exposures but this up-front work assures you will have all the data you need to complete the test. In the event you have a problem, good records make trouble-shooting much easier.

Many of you are thinking that the calculations could be programmed into a spreadsheet or a mathematics program. You are correct. I've chosen not to provide you with such things because I feel you will benefit by first doing the work with pencil and paper. The chain of causes and effects are easily obscured when buried in computer code.

The Film Test Checklist

Action	Worksheet
Basic Plan	Film Test Checklist
Plan Exposure Test & Record Important Data	Single Target Test Record or Multi-Area Target Test Record
Process Film	Use your technique
Measure & Record Density vs RV	Single Target RV Density Worksheet or Multi-Area Exposure RV Density Worksheet
Draw H&D Graph	Graph Paper

The first step is to gather the film-test worksheets, make copies and begin to fill them out. You will find that the sheets will help guide you through the whole process from beginning to end.

Next, get a supply of the film you like to use. Obtain a fresh stock of your favorite developer too. The full test and trials will use 120 exposures. This may seem like quite a lot of film to use on a test. But your investment is secure until the manufacturer changes the film.

I recommend you use a normal focal length lens or longer for the tests. If you don't already use a lens hood, now is the time to get in the habit. Be sure to use the same equipment for the whole test. If you have a shutter with "iffy" speeds, having it cleaned, lubed, adjusted (CLA), and measured before you commit to the test would be wise.

You will need a target; but how big? It needs to be big enough to produce an image on the film that is convenient to read. I like the target image to be about 10 mm (3/8") square or larger. To eliminate exposure compensation for magnification, I recommend that the target be at least 8 times the focal length away from the lens. For example: if I use my 210 mm (8 ¼") lens for the test I should place the target at least 1.7 meters (8 x 210 = 1,680 mm) or 66" away from the lens board. With the camera 1.7 meters from a wall, I simply look at the image of a tape measure on the focus screen to find how big a target I need.

The target should be a medium shade of neutral gray. The exact shade is not critical. The target could be a large piece of mat board, a painted sheet of plywood, or a smooth wall. Several photo equipment vendors sell a nice 18% reflectance gray card though for our purposes the actual value is irrelevant. You want a target that is big enough and of uniform reflectance across the whole surface.

Before you actually make the exposures, do a dry run the day before so you are sure about location, position of the sun, automatic sprinklers, etc. Pick a background that is free of bright reflections that could cause your lens to flare (remember to use a lens shade). Also, work out the mechanics of how the target will be supported, where to set the tripod, etc. Did I mention that having a helper to record information and keep things in order is invaluable?

You should plan your test for a time of day when the light will remain constant on the target. The test does not have to be shot in direct sunlight. Shooting the test in open shade or under a cloudy sky will work just fine. I have done several tests in the open shade of my garage on both cloudy and sunny days. You will need about 40 minutes to make the exposures if you follow the pre planning steps outlined below.

Choosing the Range of Development Times

From our list of considerations one item requires some serious thinking; we need a practical range of development times.

By practical I mean the processing times will cover a wide range of scenes without having to spend your life in a dark room. The easiest place to start is by using the manufacturer's recommendations for development time and film speed. (Yes, this is the one time in the VIDEC system where you will use a film speed.) I will leave it to you to choose which film and developer combination suits you.

After doing my eighth iso-density test, I finally observed that the useful development times follow the same pattern as the progression of *f*/stops on a lens. For example, the manufacturer of one film recommends a 10 minute development time. So now when planning a test, I choose a set of development times that goes like this: 5.5, 8, 11, 16, and 22 minutes. Note that the sequence is very close to the f/stop sequence. Rounding out to whole numbers makes life in the darkroom just a little easier.

Caution! Some film manufacturers are quite optimistic about the film speeds they publish. Check the World Wide Web for sites and forums that post other user's experiences. There is a certain French manufacturer that claims the exposure index for one of their films is ISO 200. My tests show the film to have a speed of about 50 when developed in D-76 diluted 1:1. If in doubt, run your own test.

The choice of development time is not critical because the iso-density graph is predictive of every development time within the tested range. Five development times are sufficient to cover all but the most extreme exposure conditions.

I prefer 10 or 11 minutes as my middle time because I have not had good results with development times shorter than 5 minutes. If the manufacturer's recommended time is 6 minutes, I will dilute the developer to obtain a longer time. For example, Ilford recommends using DD-X developer diluted 1:4. With one of the Ilford films, this results in short development times so I use a 1:5 ratio and get the development time range I like. Alternatively, you could use a series starting at 4 minutes (analogous to *f*/4 in the aperture series) if you are confident in your technique.

The Single Area Target Exposure Test Plan

Use the Single Target Test Record worksheet to plan and record exactly what exposure each frame of film will receive. There are ten steps to complete the form. I recommend you do a dry-run first.

Step 1 – Fill in the general information. Reference the Film Test Checklist you prepared. Check that your spot meter is set for ISO 100 so it reads out in LV units.

Step 2 – Using the film speed recommended by the manufacturer, look up the SV (APEx speed value) for the film and record it in the formula block. For example: looking up ISO 400 film in the table shows that SV is 2.0

Step 3 – Make a light meter reading of the test target in LV units. Record it in the formula block.

Step 4 – Calculate EV' by adding SV to LV. Round the result to the nearest whole number. Record the result in the formula block.

Step 5 – Transfer the rounded EV' to the EV column on the worksheet where indicated by the arrow.

Step 6 - Fill in the EV number series. As you go down the column from EV', add the value in the Exposure Range column to EV'. The decreasing value pattern will become obvious immediately.

As you go up the column from EV’, note that the increments are ½ stops. The value of EV will increase as you add the value in the Exposure Range column to EV’.

Step 7 – Write the value for the minimum whole *f*/stop on your lens in the *f*/stop column next to Frame #1. Fill in the column with the *f*/stop series from the *f*/stop Table.

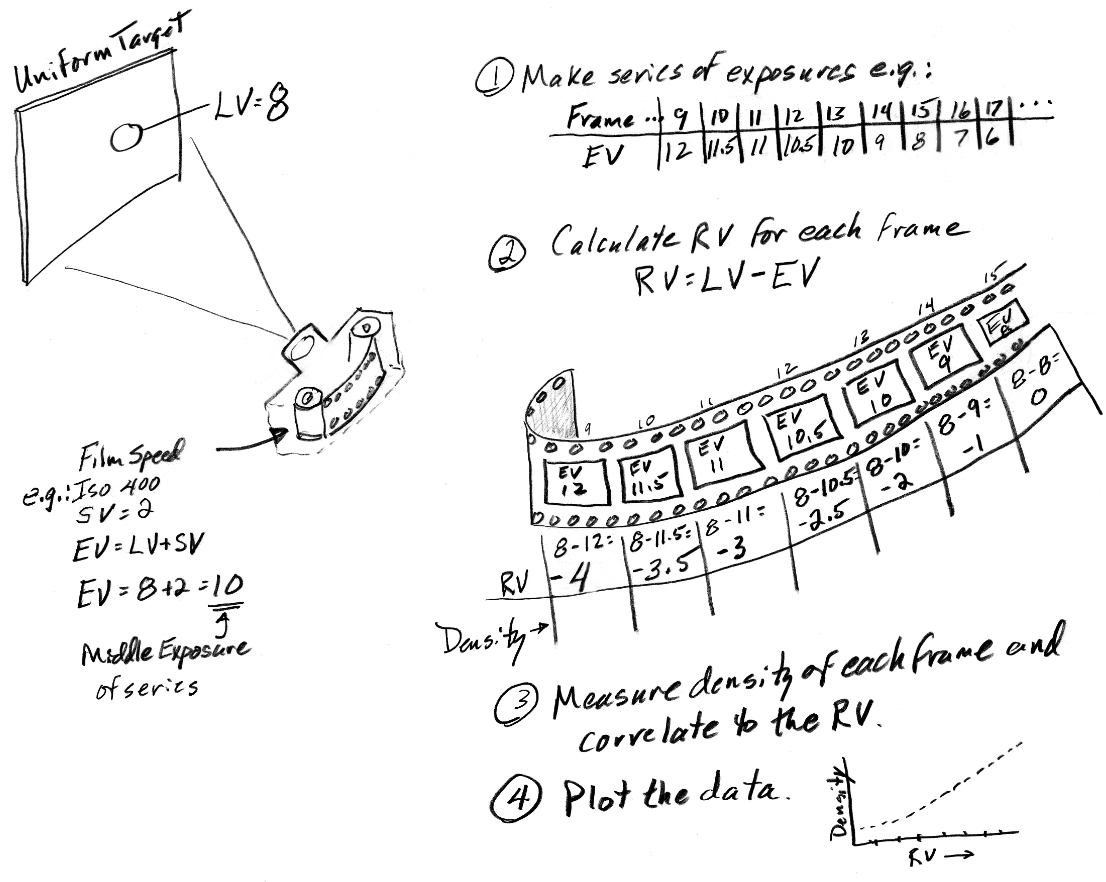
Be careful! The first 13 entries are in ½ stop increments and the remaining 5 are in 1 stop increments. Greater precision is needed at the threshold end of the curve so the exposure increments are spaced closer together. You can put the exact value in the column from the *f*/stop Table or just put a dot to hold the place for the ½ stop values. Proceed down the column until you reach the last whole *f*/stop for your lens.

For example: I have a Rolliecord with a lens that ranges from *f*/3.5 to *f*/22. So I would begin the column at Frame # 1 with *f*/22 and would reach *f*/4 at Frame # 11. Likewise I have a Nikon lens that ranges from *f*/1.8 to *f*/22. So I would begin the column at Frame # 1 with *f*/22 and would reach *f*/2 at Frame # 14. In either case, once I have reached the maximum whole *f*/stop, simply repeat that *f*/stop for the remainder of the frames.

Step 8 – From the *f*/stop Table, look up the value of each *f*/stop you just entered and record it in the corresponding cell in the AV (Aperture Value) column. You can combine Steps 7 and 8 into one operation if you like.

Step 9 – Now calculate the value of TV (time value) corresponding to each frame number. Simply subtract AV from EV and get TV and record the result. Again, you will see a simple pattern develop. You’re almost there.

Step 10 – Using the TV/time Table, look up the time (shutter speed) for each value of TV in the column and write the result in the time column.



Exposing The Film

The three right hand columns of the sheet are now your exposure plan. Most photographers can expose this series in under 2 minutes. The only snag you might encounter at this time is if the light has changed. Make one last reading of the target and compare it to the first. If you are within plus or minus one LV unit, simply record the target LV at the time of exposure and expose the sequence quickly. It is good practice to read the target LV after exposing the sequence just to be sure nothing changed. Record this value as accurately as your light meter will allow.

Now, shoot one frame with the lens cap on. This frame will be used to measure the Gross Fog (base plus fog density). This value is important to evaluate the minimum exposures in the series to assure they encompass the threshold sensitivity of the film.

Before breaking down the test, double check all calculations spot meter, and camera settings. If you are confident of your work you could expose film for all five development times. However, I strongly recommend you process this one test and plot the results to be absolutely sure you do not have any problems.

Process the film for the middle time in the sequence you planned on the Film Test Checklist. Do this using your normal work habits, equipment, and materials. Don't introduce any unneeded variables at this time. When the film is dry, you are ready to read the densities.

Tabulating The RV and Density Information

Make some copies of the Single Target RV_Density Worksheet. It has columns for the frame number, EV (exposure value), target LV and density. Of course, the target LV is the same for all the frames. Each frame will have a different EV value. From these two values you can calculate how much light energy got to the film. That value is RV (exposure).

Simply subtract EV from LV to get RV. Record the value for each frame. Again you will see a pattern in the results as you look down the RV column.

Drawing a line between the data points is just like filling in the blanks. The idea behind penciling in a curve is that we can be reasonably sure the places between real data points will provide good information. This requires that you have enough data points to establish the true shape of the curve.

Reading Densities With A Densitometer

Follow the manufacturer's directions for adjusting and using the instrument. If you don't have a densitometer, please see the Appendix for instructions on using your spot meter as a densitometer.

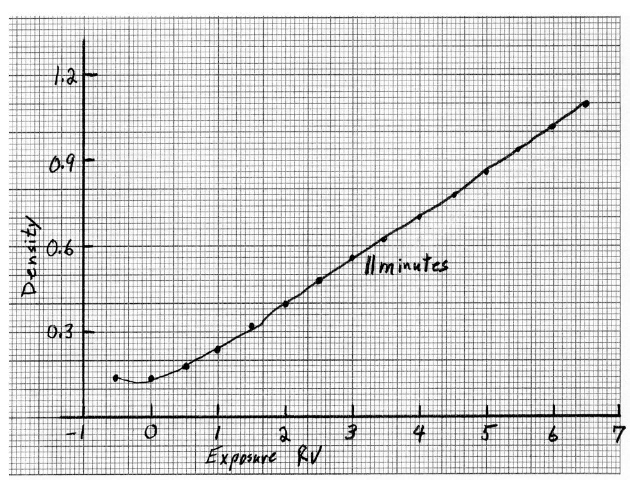
Handle the processed negatives with care. Do not touch the image area. Fingerprints, abrasions, dirt and scratches will affect the readings and adversely affect the precision of your testing.

Be consistent when taking density readings. It is best to take readings from the center of the negative to reduce error due to lens fall-off or other anomaly. The only exception is when the film has a defect such as a dust spot, air bell or pinhole. Do not read the defect.

Read the density from each frame and record the value adjacent to its frame number on the Single Target RV_Density Worksheet.

Plotting the H&D Curve

Make some copies of the graph paper pro-



vided or use your own. Use this paper to plot the curve. Plotting (or drawing) the curve is a simple matter of putting a point on the graph paper that corresponds to each pair of numbers, the RV and density values.

Starting with frame # 1, read the RV value from the RV_Density worksheet. Find that value along the RV axis (bottom line) then follow the line up until you arrive at the corresponding density value. Mark that point on the graph with a small dot. Do the same for all the other frames you exposed. Make a small horizontal mark for the Gross Fog reading.

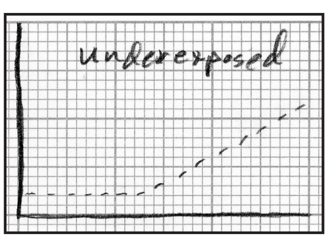
The series of dots will form a curved shape. Connect the dots to form the curve. It is perfectly fine to "average" the dots so it forms a smooth line so long as the deviations are not too great. I often use a French curve to help my unsteady hands.

Congratulations! You now have an H&D curve that conveys the relationship between the exposure you gave the film and the resulting density for that degree of development. Before you do the full test, evaluate your H&D curve against the following criteria.

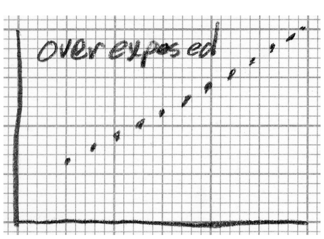
Is It A Good Curve?

There are several flaws that are easily recognized by examining the H&D curve.

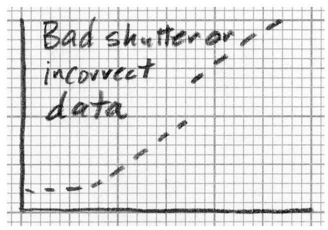
• If too much of the data is below the threshold sensitivity then we have wasted film and will not have enough data. It means that the series was under exposed by the RV difference below the threshold or your calculations are in error. Double check all calculations. If no error is found, use a lower SV and repeat the test.



• If the curve does not extend down to the Gross Fog, then the series was overexposed or your calculations are in error. Double check all calculations. If no error is found, use a higher SV and repeat the test.



• If the data suddenly jumps up or down your data collection or calculations may be in error. You may have a slow or fast shutter at a particular speed. Double check all calculations and your plot. If no error is found, check your shutter for accuracy. If a calculation error is found, correct it and re-plot the data.



Check the angle or slope of the straight line portion of the curve. It should be between 25 and 35 degrees. Some film/developer combinations never achieve a straight line portion so you will have to find an average slope. Close is good enough for this quality check. If the slope is out of range, double check all processing steps. If everything seems in order then try these correctives:

• If the slope is less than 25 degrees, then you should adjust for a higher degree of development. You can do this by moving the development time up one step in the series. For example, instead of 8 minutes you would use 11 minutes. Or you could decrease the dilution ratio; for example, instead of a ratio of 1:4 you could try 1:3.

• If the slope is greater than 35 degrees, then you should adjust for a lower degree of development. You can do this by moving the development time series down one step. For example, instead of 11 minutes you would use 8 minutes. Or you could increase the dilution ratio; for example, instead of a ratio of 1:4 you could try 1:5

• If you found a flaw that requires a correction, then plan your new test and repeat the cycle.

Assuming all went well (or could be corrected) on the baseline test, then plan out a full test. I recommend that you expose for all five development times. You can use your baseline test to see how repeatable your technique is.

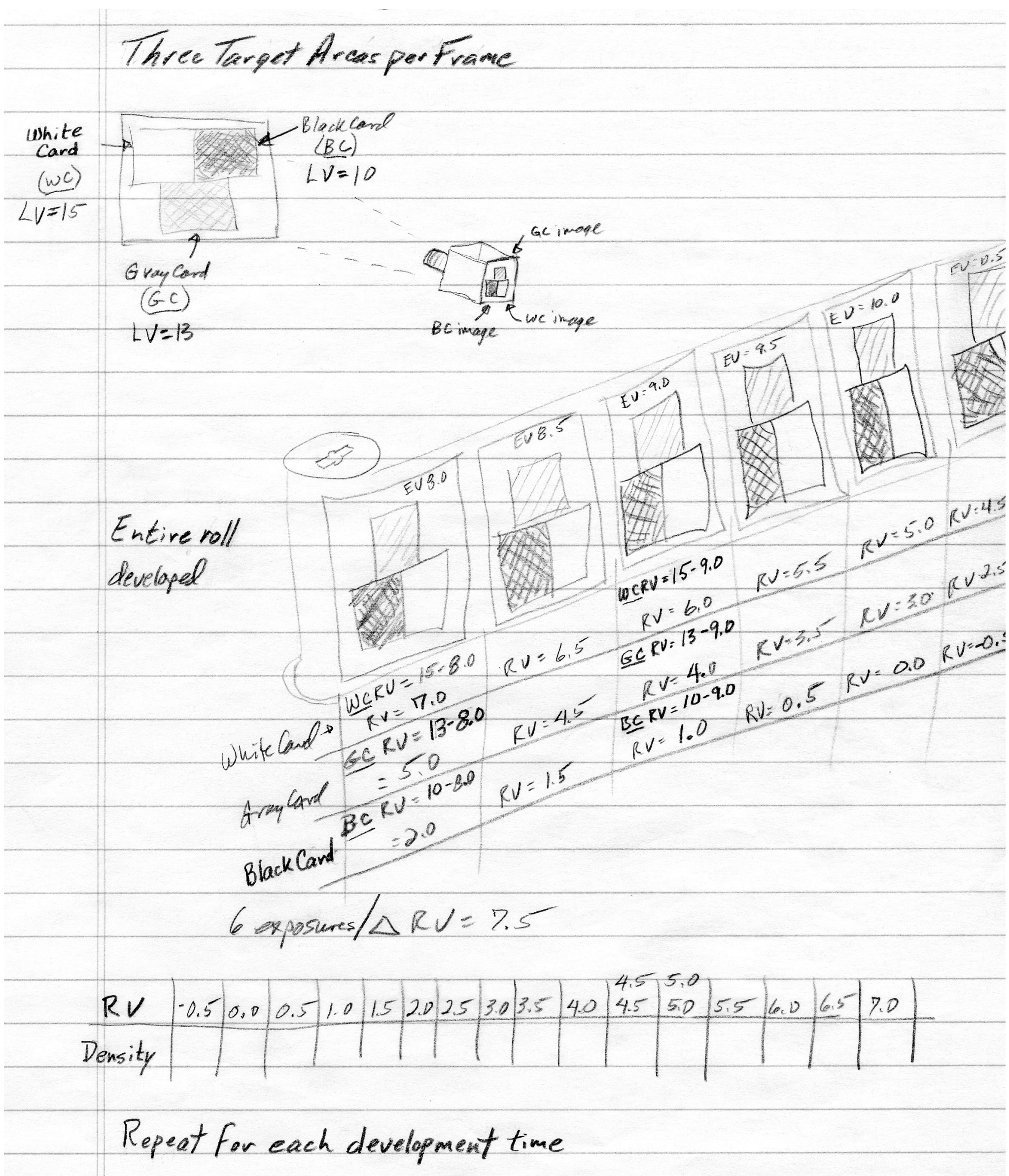
The Multi-Area Target Test

Because this test is a bit more complicated than the single-area test, it is written as though you are going to perform the entire test for all development times. However, I recommend that you perform only the middle development time test as your baseline. Once you are sure your curve looks good, then perform the entire test. At the end of this section I will provide instructions so roll film users can take advantage of this method.

How A Multi-Area Target Works

Envision a target with three areas on it, white, black and 18% gray. When I focus the image of the target on the screen the three areas will be easily seen. If I measure the luminance of each target area I will get three different readings. Using the APEx formula for exposure (RV) I can calculate the exact exposure each target area delivers to the film. The formula is simple, RV = LV – EV. Using my spot meter I measure each area of the target and get LV 15 for the white area, LV 13 for the gray area and LV 10 for the black area. The camera settings at the time of exposure are *f*/8 at 1/30 second which is EV 11.

The simple way to do the calculations is to make a table. This table includes an empty column so we can enter the density reading later. RV and the density are the coordinate pair we will use to



plot the H&D curve.

Target Area	LV -	EV	= RV	Density
White	15	11	4	
Gray	13	11	2	
Black	10	11	-1	

A 3-area target produces 3 coordinate pairs (density and exposure) per sheet or frame of film. We are on the right track but there are some drawbacks to just 3 areas. The exposure interval from white to gray to black is several RV units (or stops). It is difficult to plan camera settings to provide evenly spaced exposure intervals and so there is no major material savings. But if the number of areas is increased, a multi-area target can work very well.

Making a Practical Multi-Area Target

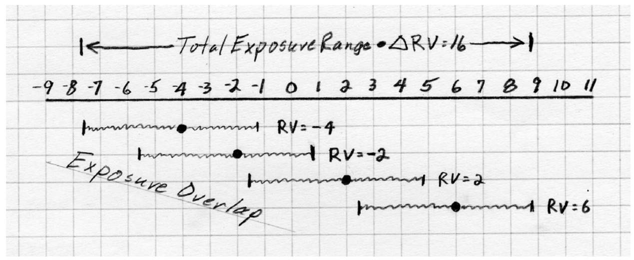
My target is pretty fancy. I bought a set of art papers in ten shades of gray from white to black and glued them to pieces of hardboard. Each area is 10” x 18”. You could easily buy small quantities of black and white paint and mix your own shades of gray.

I made two identical sets and hinged the matching pair with tape so I can form a “V” shape when I stand them up. I arrange them so one half of

the “V” is in the shade and the other half is in the main light. With this configuration, I get 20 density readings for every exposure with some overlap.

The target luminance range from white to black is 5 RV units (5 stops). Configuring the target to have a shadow side adds 4 more RV units for a total range of 9 RV units. So in a single photograph I can have 20 distinct exposures that are easy to measure and encompass a sizeable RV range.

By carefully managing the exposure plan, I can make a complete test with a modest amount of film.



To make my life (and yours) easier, I have built the overlap calculation right into the Multi-Area Test Plan worksheet.

Completing the Multi-Area Target Test Record

This is the worksheet you will use to plan and record the exposure each sheet of film will receive. There are seven steps to complete this form. I recommend you do a dry-run first.

Step 1 – From the Film Test Checklist, enter the following. First enter the Film Test Name. Then, in the Exposure Blocks area under the Development Times column, enter the five chosen development times. Finally, enter the Speed Value (SV). Using the film speed recommended by the manufacturer or other trusted source, look up the SV (APEx speed value) for the film and record it in the EV’ Calculation block. For example: looking up ISO 200 film in the table shows that SV is 1.0

Step 2 –Lay out your film holders in sequence and fill in the Holder # cells from top to bottom, left to right in that same sequence.

Step 3 – Make light meter readings of all the test target areas. Check that your spot meter is set for ISO 100 so it reads out in LV units. Record the readings in LV units. Record the readings in the corresponding blocks being careful to distinguish between the bright and dark side of the target area. Note the time when you took the readings in the cell "time **a** ____".

Step 4 – Transfer the reading from target area F (bright) to the EV' Calculation Block. Perform the calculation adding LV_F to SV. Rounding this value to the nearest whole number, enter it as **EV'** in the Calculation Block. (Note: target area (F) bright is one of the middle grays with reflectance pretty close to an 18% gray card. The precise reflectance is irrelevant since we are only interested in the luminance value the target area generates.)

Step 5 – Transfer the value **EV'** to each of the four columns in the Exposure Block. Perform the calculation by adding or subtracting the Exp. Range value as indicated for cells **EV'_1**, **EV'_2**, **EV'_3** and **EV'_4**.

Step 6 – In each Exposure Block, determine a good *f*/stop and shutter speed combination by using the reference table at the bottom of the worksheet. Remember the formula EV = AV + TV. Record the *f*/stop and shutter speed in the corresponding cells under **EV'_1**, **EV'_2**, **EV'_3** and **EV'_4**.

Step 7 – Read a few of the target areas to be sure the lighting has not changed. If the change is within plus or minus 1/3 LV, begin exposing the film.

If the light change is greater than 1/3 LV but less than 1 LV unit, take new readings and record them in one of the secondary areas. You do not need to recalculate EV'. That degree of change is within the tolerance of this test procedure.

If the light change was greater than plus or minus one LV unit, you will have to take new readings and recalculate EV' based on the new readings.

Exposing the Film – Sheet Film

Follow the plan. Have your assistant call out the camera settings as you change the film. If you lay out your film holders in shooting sequence, exposing the film will take just a few minutes. Success rests in doing everything step-by-step. Double check your camera settings as you complete each block. Photograph one block at a time. When you process your film, be very careful to keep track of everything. I recommend you process all the film for each development time in one session.

To build the H&D curves for this test, go back a few pages and perform the steps under the heading "Tabulating the Density Information."

Exposing the Film – Roll film - 120 size formats

Roll film users can use this plan with one modification to the procedure. Expose the roll by going across the Exposure Blocks. That is, for your first roll which you will develop at the first development time expose for the columns **EV'_1**, **EV'_2**, **EV'_3** and **EV'_4**. You will make 4 exposures changing camera settings for each one. Again, having a knowledgeable assistant is a huge help.

If you have a camera or back that spaces frames consistently, then you can expose the second development time on the same roll. In the darkroom you can cut the roll in half and process each for the indicated time. 10 or 12 exposure cameras will allow you to put blank frames in the middle of the roll to assure you won't cut into a needed image. You can expose the whole test on 3 rolls of film with a few frames to spare.

Summary

Remember why we are going to all this trouble. The end result is an easy-to-use system that is optimized for you.

Here are the steps:

- Prepare the target, camera, film, chemicals, etc.
- Prepare the checklist and exposure plans
- Measure and record the target luminances
- Make the exposures and record the actions
- Develop the film
- For each target area on each negative, calculate RV from the EV and LV for the corresponding target area
- Read and record the negative densities creating a table of the RV/density coordinate pairs for each development time
- Plot the H&D curves

Chapter 12
Drawing the Iso-Density Graph

Introduction

This is the culmination of all that you have worked so hard to accomplish. The rewards are just around the corner.

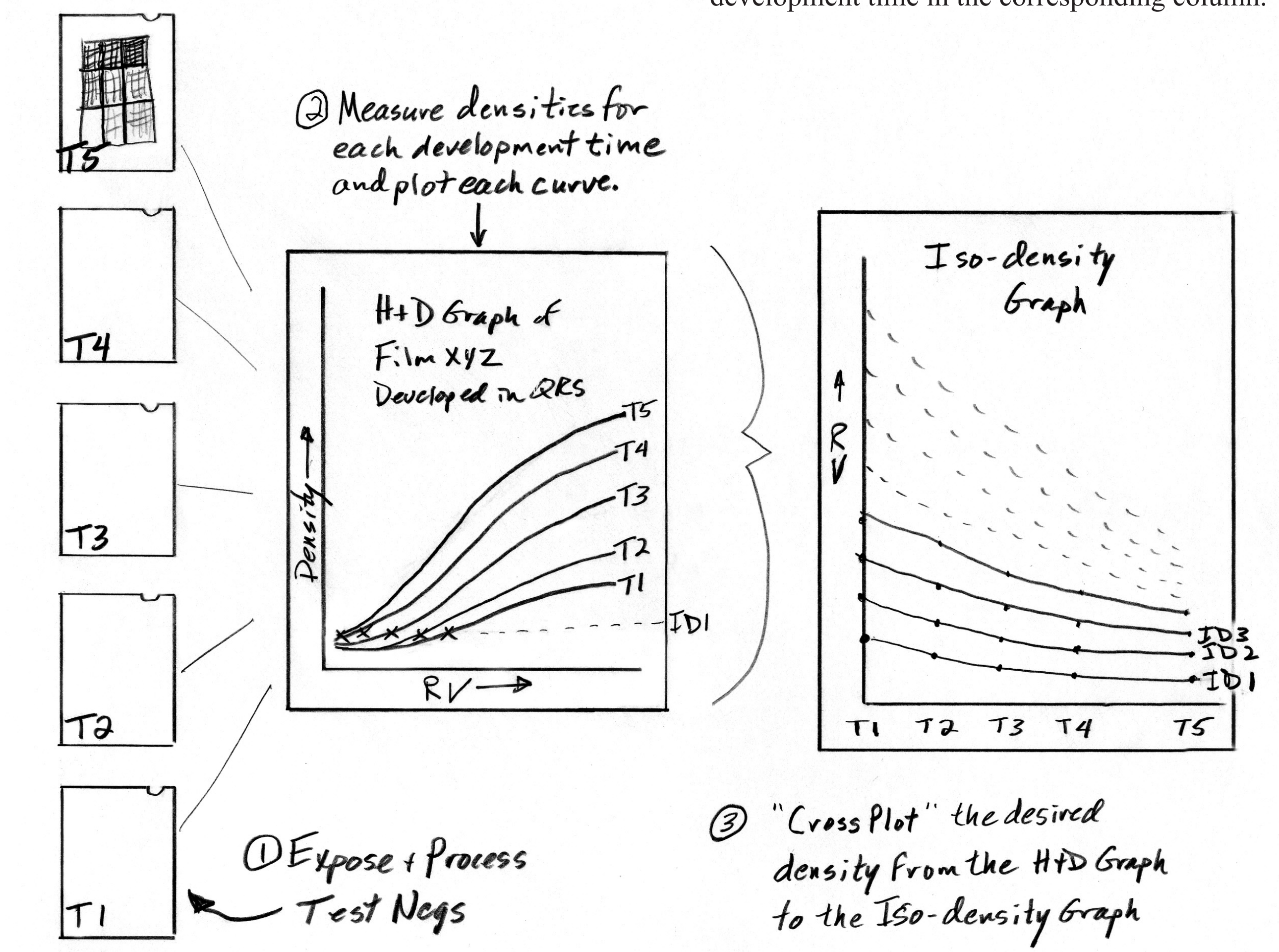
The task at hand is to build a table of data gleaned from the family of H&D curves. From that table, you will plot the iso-density graph. With the iso-density graph, the LV ruler, the STP and your refined sense of effective relationship, you will truly be masters of exposure and development control. Fortunately, this last effort is straightforward so let us proceed.

Drawing the Iso-Density Graph

To complete the iso-density graph you need the fully populated H&D curves, graph paper and the Iso-Density Graph Worksheet.

Step 1- On the Iso-Density Graph Worksheet, enter the general information. Refer to the Film Test Plan as needed.

- Enter the density interval of your Step Tablet Negative/Print.
- Enter the value for the base EPD, usually 0.10.
- Enter the development time series in the five columns beginning with the shortest time to the longest.
- Enter the Gross Fog (Base + Fog density) for each development time in the corresponding column.



Step 2 - Calculate the five iso-densities for iso-step 1; that is, work from left to right entering the density into the cell in each development time column. The full formula is:

Density =
Gross Fog + Base EPD + ((Iso-Step # - 1) x STN interval)

For example:

- Gross Fog (@ shortest dev. Time) = 0.11
- Base EPD = 0.10
- Iso-Step #1
- STN interval = 0.15

Density for Iso-Step 1, Development Time 1
= 0.11 + 0.10 + ((1 – 1) x 0.15) = 0.21

As you repeat this calculation in each column, you will see that the only change to the density value is contributed by the change in Gross Fog as the development time increases.

Step 3 - Using the family of H&D curves, look up the RV needed to generate the density reading. For example: Using the curves for Ilford Delta 100 and starting with the 5-minute curve, I found the density 0.21 on the density axis of the graph and read across the graph to the corresponding point on the curve. Reading down from that point, I determined that the exposure for that density was –3.6 RV units. I recorded this result on the iso-density table. I repeated these steps for the remaining four development times.

Step 4 - The five pairs of values you just recorded are the coordinate pairs needed to plot the iso-density curve for iso-step 1 (the base step). Plot these values on the graph paper now. Using a French curve or drawing free-hand, connect the dots to form the iso-density curve. Compare your curve to the example shown.

Step 5 - Repeat Steps 2, 3, and 4 until you have made as many iso-steps as you want or until you run out of data. As a minimum, you must have at least as many iso-density curves as you have visible shades of gray on your STP. Compare your results with the iso-density graphs in the appendix. Yours should follow the same pattern.

Continuing the previous example:

Density for Iso-Step 2, dev. Time 1
= 0.11 + 0.10 + ((2 – 1) x 0.15)
= 0.36

Step 6 - Label your graph carefully. As a minimum, include the film designation, developer, dilution, development temperature, and the date the test was performed.

Step 7 - On a clean sheet of the same graph paper and to the same scale as the RV axis, draw up at least one LV ruler.

Making the Iso-Density Graph Field Worthy

I like to plot my graphs on tabloid size (11" x 17") paper. I reduce the iso-density graphs onto letter size (8½" x 11") paper. The critical issue is to make sure the LV ruler and the iso-density graph are reduced the same amount. I have adopted 65% as my standard reduction and use that figure every time I copy the original iso-density graph and LV ruler.

When I make up my exposure record sheets, I copy the LV ruler along the right side. This eliminates having to carry and use a separate LV ruler. However, it is vital that the LV ruler be scaled to the same size as the iso-density graph.

I put my letter size graphs into clear plastic sheet protectors and put them into the pocket of a thin 3 ring binder that I carry with my large format gear. I punch a stack of Exposure Record sheets and insert them in the binder. I keep the STP with the graphs.

Make extra STPs. Always take two along in your camera case. Sooner or later one will blow over the cliff. Consider mounting your STP to a medium gray board. A black or white board will skew the appearance of the gray scale due to a visual phenomenon called simultaneous contrast.

I keep at least two mechanical lead pencils in the camera case with the 3 ring binder. I like lead pencils for field work because they don't freeze, leak or run. I've tried using water proof paper (surveyors field note paper) but have found that a good grade copy paper works well under all but the most severe conditions.

Concluding thoughts

I wish there was a shortcut to obtaining your personal iso-density graph. But there is none. On the other hand, I would not want to deny you the opportunity to learn first-hand how your materials really perform. As I account for my time to do a complete test, I find I have about 16 hours of time invested. Is it worth it? For me the answer is an unqualified “Yes!”.

With the first test you complete, you can legitimately claim to being fully engaged in the art and craft of black and white photography. Congratulations!

If you have enjoyed some success with VIDEC already, experienced intense frustration, found errors or omissions, or if you think I am a sinner or a saint, I hope you will share these things with me. I applaud your every effort and I celebrate your every success.

Now, go make some great photographs!

Chapter 13 Glossary of Terms in Tutorial Sequence

The following terms are arranged to build your understanding of basic photographic principles.

A Scene is the view encompassed by the film in the camera.

Illuminance is the visible light falling on a surface. It can come from one source or many. In like manner, the light at the film plane imaged by the lens is illuminance; that is, the image formed by an area in the scene illuminates a corresponding area of the film.

Luminance is the light reflected or emitted from a surface. A light bulb emits light and a ping pong ball reflects light.

An Optical Image is a representation of the scene formed by an optical system. The camera lens organizes the light from the scene forming the image at the plane of focus. The image is made visible by placing, at the plane of focus, a reflecting surface (e.g., a projection screen), a scattering surface (e.g., a camera's focusing screen), or a photosensitive material (e.g., film or an electronic detector).

APEx stands for Additive System of Photographic Exposure. It uses whole numbers to represent *f*/stops, shutter speeds and film speeds, and other photographic exposure-related variables. This presentation is not in conformity with the ANSI standard; however, it does follow common industry practice.

Proportional Intensity is the relationship between the luminance of an area in the scene and the illuminance of that area at the image plane. A high-quality lens will produce a nearly perfect one-to-one correspondence between the luminance differences in the scene and the corresponding illuminance differences of the optical image. Proportional Intensity is expressed by the APEx formula:

IVq = LVq - AV

Where IVq is illuminance at a specific spot on the film plane formed by the image of some area (**q**) in the scene.

LVq is the luminance of the area **q** in the scene

AV represents the aperture (light gathering power) of the lens

Exposure is the work done by light energy on the photosensitive material. Exposure occurs when a photosensitive material is subjected to illuminance for a finite period of time. If we expose a piece of film to three units of illuminance for one second, the exposure is 3. If we expose the film to four units of illuminance for two seconds, the exposure is 8 and so on. Exposure = Intensity x Time. Illuminance is measured in meter candles (one meter candle = one lux); therefore, exposure is measured in meter candle seconds or, in SI units, lux seconds. Exposure is expressed by the APEx formula:

RV = IV - TV.

The ordinary Exposure Controls are comprised of the aperture and shutter. The intensity of the exposing light is moderated by the aperture. The duration of the exposing light is moderated by the shutter speed. The combination of these two controls is represented by the APEx term EV.

Scene Luminance Range is the difference between the highest luminance in the scene and the lowest luminance in the scene. The photographer decides which areas are important based on his or her interpretation of the scene. Scene Luminance Range is sometimes loosely referred to as subject contrast.

Image Illuminance Range is the difference between the highest illuminance focused on the film and the lowest illuminance focused on the film. Image Illuminance Range is directly related to the Scene Luminance Range (see Proportional Intensity). Although they are proportional in most cases, lens flare and other factors may measurably reduce the image illuminance range.

Exposure Range refers to the difference in exposure delivered to the film by two areas in the scene, usually the darkest and lightest areas. Sometimes this term is used interchangeably with Scene Luminance Range.

Contrast is a term loosely applied to many aspects of photography. High contrast refers to a large difference in scene luminance range, negative density range, or print density range. Low contrast is the opposite; referring to a small difference between extremes for scene luminance, negative or transparency density and print reflected density. Contrast in a print has distinct psychophysical effects. For example, the perception of sharpness is related to contrast; the higher the contrast, the higher the apparent sharpness.

Local Contrast is the luminance difference of a small scene area without regard to the contrast of any other area of the scene. It may also describe the density differences in small areas of negatives, transparencies and prints.

Effective Relationship is the sublime visual effect caused by the translation of the brightnesses of a scene onto the limited density range of the photographic print. It is an illusion that occurs when the shades of gray in the print give strong visual cues to our vision system. These cues may include the presence of detailed shadows, a textured white, a skin tone or other visually important features. When the visual cues cause the desired effect on the viewer, the shades of gray are in Effective Relationship.

Sensitometry is the scientific study of the effects of exposure and development on photosensitive materials; specifically, the optical density resulting from exposure and development.

Sensitivity is the measure of how much exposure is required to produce a particular optical density in the processed negative. Sensitivity is dependent on the film, developer, and degree of development.

Development is the action of certain chemicals on photosensitive materials that selectively changes only those areas which were exposed to light. The complete development process makes the image permanently visible as a pattern of densities formed in relation to the exposing light and the degree of development.

Degree of Development is the effect on film caused by the developer chemistry and the variables of developer concentration, time, agitation and temperature. In the VIDEC System, the degree of development is chosen so that the scene luminance range translates to a negative density range that matches the selected print exposure range. No single number is used to describe degree of development. However, the H&D curves derived from a film test can reveal how the image is affected as any of the variables are changed (e.g., a film-developer combination tested for a series of differing development times).

Optical Density (transmitted density) is a measure of the fraction of light absorbed by a particular area of the negative or transparency. It is defined as

$$D = \log 1/T$$

Where D is optical density and T is transmittance. Transmittance is the ratio of light passing through the negative to the light incident on it. If one unit of light falls on a negative and 1/2 unit passes through then:

$T = 0.5$ and

$D = \log (1/0.5) = \log 2 = 0.301.$

Optical Density is related to the amount of silver or dye remaining in the emulsion after processing, which is in turn dependent on exposure and development conditions.

The APEx value DV (Density Value) is used to represent optical density.

$$DV = \text{optical density}/\log 2$$

Densitometry is the science of measuring the optical density of photographic materials.

The Densitometer is used to measure the optical density of a negative. A densitometer has a stable light source, a probe to examine a small area of the negative and the electronics to measure the light. Densitometers read out directly in optical density units

Density Range is the difference between the lowest useful density on a negative and the density of the lightest area in the scene photographed. Factors affecting Density Range are the degree of development and the difference between the least and greatest exposure.

Base Density is the optical density of the film base alone excluding the density of the emulsion. Sometimes a dye is added to the film base, which increases its density substantially. This is often done to reduce halation in the film.

Halation is the effect of the image forming light scattering within the photo-sensitive coating and the film base. Halation can cause reduction in local contrast, apparent sharpness and other effects.

Fog is the amount of optical density caused by the random development of unexposed silver halides in the emulsion. Generally, fog increases as the development time increases. Increased fog can also result from defective processing chemicals, incomplete fixing, exposure to heat, radiation or humidity.

Gross Fog (GF) or "Base Density + Fog" is the sum of the base density and fog density. For practical purposes, Gross Fog is the useful measure. The sum of the two densities is measured when an unexposed area of processed film is read on a densitometer. It is sometimes called D-Min (for minimum density).

Effective Printing Density (EPD) is the density of an area on a negative less gross fog (EPD = D - GF). Because gross fog (GF) is distributed evenly across the negative, the effect of GF is null.

H&D Curve or Characteristic Curve is the graph of the relationship between exposure and resulting density when a material receives a specific degree of development. The H&D curves for several degrees of development are usually grouped together on the same graph as a "family" of curves. Each curve represents the response of the film to the specific degree of development.

Optical Density (reflected density) is a measure of the fraction of light absorbed by a particular area of a print. It is defined as:

$$D = \log 1/R$$

Where R is the ratio of light reflected from a surface to the light incident upon it.

Print Exposure Range is the difference between the amount of exposure required to yield a gray just perceptibly lighter than the darkest black obtained at full exposure and the exposure required to yield a gray just perceptibly darker than an unexposed area (paper base white). In the VIDEC System, the photographer determines these values under actual printing conditions (enlarger light source, lens, processing conditions, etc.) and viewing conditions.

Print Density Range is the reflected density difference between the lightest area on a print and the darkest area. It can be no more than the difference between the white obtained with no exposure and the darkest black obtained at full exposure. Note that the notion of proportional intensity applies to the printing system as well as the camera system. In the enlarger, the illuminated negative forms the "scene" while the lens focuses the image onto the photosensitive paper.

Contrast Grade is a number assigned to photographic paper by the manufacturer to represent the print exposure range for that paper. Papers with a large print exposure range (referred to as "low contrast" paper) are assigned a low number and those with a small print exposure range ("high contrast" paper) are assigned large numbers. The continuum of grades runs from 0 to 5. Number 2 grade usually is considered the middle of the range and is referred to as a "normal grade".

Variable Contrast Photo Paper can change contrast grade over a wide range by changing the ratio of blue and green exposing light. The usual method to choose a paper grade is to place a filter in the light path. For convenience, these filters are marked with the equivalent contrast grade number.

VIDEC is the acronym for Visually Integrated Development and Exposure Control. With the VIDEC system, a photographer can associate brightnesses measured in the scene with shades of gray on the Step Tablet Print (STP) in effective relationship. By using the STP and Iso-density Graph, the photographer's intentions can be captured on the negative in a way that results in an optimal print with good characteristics for further printing manipulation.

Iso-density Curve is the plot of the exposure needed to obtain a particular effective printing density (EPD) over a range of negative development times (degree of development).

Iso-density Graph is the family of Iso-density Curves for a particular film and developer combination. Each curve in the family of curves is plotted from a selected effective printing density. Each curve relates one effective printing density to a unique combination of exposure (RV) and degree of development of the negative. As the contour lines on map shows discrete elevation changes, so each iso-density curve shows a discrete change of effective printing density.

An Iso-step is an Iso-density Curve that corresponds to a particular Effective Printing Density (EPD). The density intervals are based on the density interval of the Step Tablet Negative used.

Lowest Effective Exposure is that exposure given a negative developed to a particular degree, which yields a density of 0.10 plus gross fog. The amount of exposure needed to obtain the Lowest Effective Exposure will decrease slightly as the degree of development is increased.

A Step Tablet Negative is a specially prepared negative composed of a series of uniform densities, each increasing by a fixed amount. For example, Stouffer Graphic Arts manufactures a step tablet negative that has 21 density steps. From a base of 0.05, the density increases in increments of 0.15 optical density units to about 3.05. Increments of 0.10 are also available

A Step Tablet Print is a photographic print of a step tablet negative. It is made under standard conditions set by the photographer. It is a portable record of the way a particular paper responds to known conditions of exposure, lens qualities, degree of development, drying conditions, et al. A Step Tablet Print can be made for each of the papers on which you print and each contrast grade as well.

A Print Step is the shade of gray formed by exposing a Step Tablet Negative under standard conditions.

The Base Step is the curve on the Iso-density Graph that is plotted from the Lowest Effective Exposure values for each development time tested.

The EV' Line is a line highlighted on the Iso-density Graph that points to the correct exposure on the LV ruler. It is drawn at RV = 0 for all development times. (See APEx definitions)

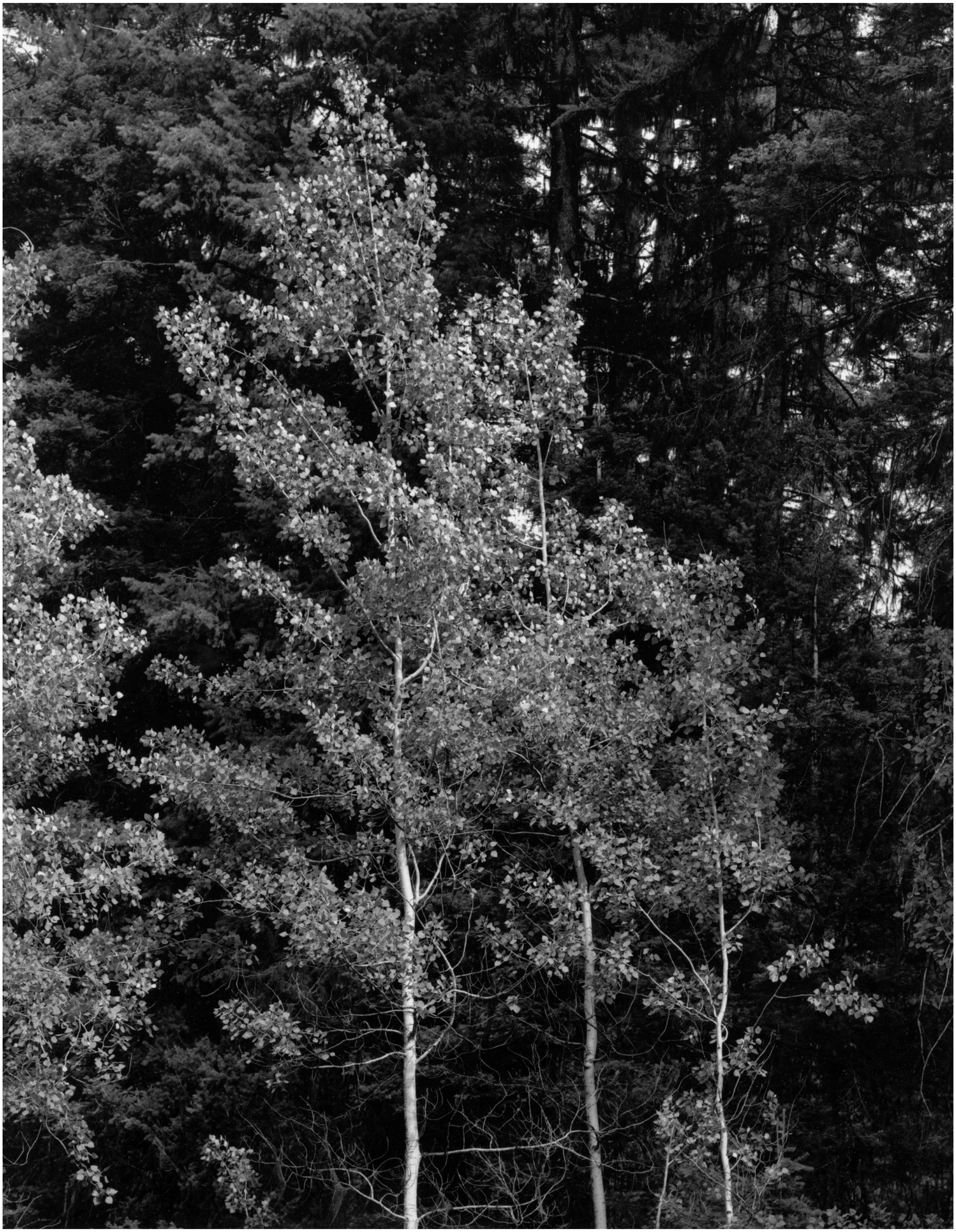
A Filter is any optical device in the image path that absorbs, scatters, or blocks light. Colored filters are used to change the effective relationship between colored objects in the scene. Polarizing filters change the effective relationship between areas of polarized and unpolarized light in the scene. Some filters absorb non-visible ultraviolet light, which could cause exposure on the film.

Most filters reduce the overall amount of light reaching the film. Some amount of exposure compensation is often needed. The effect of a particular filter on exposure depends on the particular film and filter combination. Usually the manufacturer will recommend a correction called the “filter factor” expressed as a multiplier of the exposure time. Filter factor is represented by the APEx value FV. As with other APEx values, a filter factor of 2 is equal to FV of 1, a filter factor of 4 is equal to FV of 2.

Flare is scattered light that falls on the film or paper during exposure. Sources of flare include bright sources of light shining on the lens, internal reflections between the lens elements, reflections from surfaces inside the camera, including the film itself. Flare degrades the image by reducing image contrast and apparent sharpness.

Pallet is a descriptive term used to describe the dominant range of colors or shades of gray in a photograph.

Chapter 13



Chapter 14
VIDEC - A Technical Description

Introduction

VIDEC is a method to determine both exposure and degree of development simultaneously. This method enables photographers to use any combination of tested film and printing paper to obtain a negative optimized for visual effect and ease of printing.

It is desirable to photograph a scene in such a way that the luminance range of the scene is represented on the processed negative as a particular density range. This density range is selected to facilitate printing; that is, the negative density range is matched to the exposure range of a specified print paper.

Changing the degree of development of the negative affects (to our advantage) the resulting density range. However, changing the degree of development changes the sensitivity of the film to exposure. Thus the challenge is to determine the degree of development and exposure simultaneously when both the luminance range of the scene and the exposure range of the print paper vary by choice or by circumstance.

The tools used in the practical application of the VIDEC System are the iso-density graph, the step tablet print, and a spot meter. The photographer will use his or her camera to make the test exposures and normal darkroom technique to process both film and paper. The tools needed for testing the film are a target of uniform reflectance and the spot meter. A densitometer is needed to measure results of the film test series. The result of the film test is a family of H&D (characteristic) curves. The iso-density graph is produced by cross-plotting data from the family of characteristic curves. The tools needed to make a step tablet print are the photo paper to be tested and a suitable step tablet negative.

The Camera-Film System

The optical image of a discrete area X in a scene will illuminate the film according to the relationship:

[1] $IV_X = LV_X – AV$

For a camera system with an adjustable shutter and aperture:

[2] $RV_X = LV_X – (AV + TV)$

Where IV is the image illuminance, RV is the exposure imposed on the film, LV is the luminance of the corresponding scene area measured by ordinary a photographic light meter, AV is the value representing the aperture of the lens in *f*/stops, and TV is the value representing the duration of the exposure, the shutter speed.

The effect of AV + TV can be expressed by a single variable, EV (exposure value) where:

[2] $EV = AV + TV$, therefore:

[3] $RV_X = LV_X - EV'$ and

[4] $EV' = LV_X - RV$

Where EV’ is the unique combination of AV and TV at the moment of exposure.

Equation [3] establishes the means by which an ordinary light meter can be used to determine the exposure delivered to the film for any area in

$$\Delta RV = RVq – RVr$$

$$\Delta LV = (LVq - EV') – (LVr – EV')$$

$$RVq – RVr = LVq – LVr$$

[5] $\Delta RV = \Delta LV$

the scene.

Equation [4] computes camera settings when LV and RV vary.

Equation [5] shows that the luminance difference between any two scene areas q and r establishes a corresponding exposure difference at the film (disregarding flare and other losses) when the exposure is made.

The Characteristic Curve

The traditional method for characterizing the performance of a film developer combination is to plot the density that results from a range of exposures, the film being given a specific degree of development (developer composition, strength, time and temperature). Testing at several discreet degrees of development forms a family of curves commonly known as the H&D (after Hurter and Driffield) or characteristic curves.

The Printing System

In the simple case of a negative printed by placing it in contact with photographic paper, the light source illuminates the negative plane with perfect uniformity. The negative forms the image by blocking light in relation to the optical density of the negative at any given point on the negative. Therefore, the intensity of light at the image plane, where the print paper will be exposed, is proportional to the intensity of the light source less the amount of light absorbed by the negative. If the print is made by projection in an enlarger, the magnitude of the intensity at each discrete location will vary uniformly as the enlarging lens aperture is changed.

Assuming the case of a contact print, the relationships are described in the following formulas in APEx terms.

A uniform light source illuminates the negative with intensity of IV_N. A discrete area Q of the negative has an optical density of DV_Q. The intensity of the illumination at the photographic print paper is equal to the intensity of the source minus the optical density of the negative.

$$IV_Q = IV_N - DV_Q$$

The exposure received by the print paper at area Q is a function of the intensity of the light and the exposure time. Where PV_Q is the exposure at the print paper, then:

$$PV_Q = IV_Q - TV$$

Photo paper, like any photosensitive material, has a threshold sensitivity and a saturation maximum. Under standard processing conditions, the threshold sensitivity is the amount of exposure that causes the paper to yield the first visually detectable density. Saturation sensitivity is the amount of exposure and not more that causes the paper to achieve its maximum density.

In normal pictorial photography, prints most favored by the public use the full range of print density. Thus, the goal is to expose and process the negative in such a way that this effect is achieved. (The Theory of the Photographic Process, Revised Edition 1954, C. E. Kenneth Mees, D.Sc., F.R.S., Chapter 23)

The saturation and threshold exposures can be expressed as a difference. Because the negative directly affects the intensity of light at the print paper plane, we can express the printing exposure range of the paper as the density range of the negative. Where PVt is the print paper threshold exposure and PVs is the print paper saturation exposure:

$$PVt = IVt - TV$$

$$PVs = IVs - TV$$

Where PV_Q is the exposure at a particular point, Q, in the print image plane and DV_Q is the density at a particular point, Q, in the negative image plane, then:

$$PV_Q = IV_N - DV_Q - TV$$

$$PV_Q + DV_Q = IV - TV$$

$$DV_Q = IV_N - TV - PV_Q$$

For two points on the print image, Q and R, such that $PV_Q = PVt$ and $PV_R = PVs$, then:

$$PV_Q + DV_Q = IV_N - TV$$

$$PV_R + DV_R = IV_N - TV$$

$$PV_R + DV_R = PV_Q + DV_Q$$

$PV_R - PV_Q = DV_Q - DV_R$

$\Delta PV = \Delta DV$

For example: where TV = 3, $IV_N = 9$, PVt = 3, and PVs = 5, then:

$DV = IV_N - TV - PV$
DVt = 9 - 3 -3 = 3
DVs = 9 - 3 -5 = 1
5-3 = 3-1

Step Tablet Print (STP) to Base Step Correspondence

A Step Tablet Negative is a specially prepared negative composed of a series of uniform densities each increasing by a fixed amount. For example, Stouffer Graphic Arts manufactures a step tablet negative that has 21 optical density steps. From a base density of approximately 0.05, the density increases in increments of 0.15 to about 3.05. Increments of 0.10 are also available

The Step Tablet Print

A Step Tablet Print (STP) is a photographic print of a step tablet negative. It is made under standard conditions that the photographer sets for him or herself. It is a portable record of the way a particular paper responds to known conditions of exposure, lens qualities, degree of development, drying conditions, et al.

STP Step 1 is printed such that it is the first perceptible shade of gray lighter than maximum black. This assumes good viewing conditions where illuminance at the print surface is 32 foot-candles or greater. This determination is relative to both the viewer and the viewing conditions. However, tests with 20 observers under a wide variety of viewing conditions show there is good agreement that the first visible step is at least 0.06 less dense than the maximum black density for a variety of photo papers.

Given the prior assertion, Print Step 1 can be printed from any negative density. For example, a certain negative has two large uniform areas of density. The first has a density of 0.30 and the second has a density of 0.60. If printing conditions are arranged so that the 0.30 density prints as Print Step 1, then it is possible to make a second print so that the 0.60 density prints as Print Step 1 simply by doubling the intensity of the exposing light. When the 0.60 density is printed as Print Step 1, the 0.30 density will deliver more than enough exposure to print as maximum black.

Therefore, any density above gross fog can be used to print Print Step 1. How much density above gross fog is an important question. Listed here are three important considerations that will affect the choice.

First, a safety factor can be added to account for shutter speed variations, processing variations, rounding errors, etc. The higher the density chosen, the more variation can be tolerated. However, it comes at the price of increased graininess in the print if the variations result in a net increase in exposure to the negative.

Second, the shape of the film's characteristic curve will have a significant impact. A photographer may choose to place the range of scene luminances entirely on the linear portion of the characteristic curve for aesthetic reasons. This usually entails a large offset. When photographing a low-key subject, photographers often want to retain separation of the dark values. This is accomplished by placing the exposure for print step 1 on iso-density step 2, an effective offset of 0.25 above gross fog (using a step tablet with 0.15 increments).

Third is the response of the print paper. The relationship between the characteristic curve of the negative, the characteristic curve of the print paper, printing methods, viewing conditions, etc. have a substantial influence the choice of a base density. The theory of tone reproduction provides a basis for comprehensive analysis.

The Iso-density graph

Because the printing paper is tested using a Step Tablet Negative of uniformly increasing steps of density, it is useful to re-plot (or cross-plot) the characteristic curves to a graph that plots exposure and development for selected densities. By definition then, each iso-density curve is a plot of the exposure (RV) required to achieve a specified density (above the gross fog) at each development time in the tested range. This family of curves is the iso-density graph.

A Kodak #2 Step Tablet Negative with a density difference between each step of 0.15 was used. The densities are chosen to correspond to the density increments of the Step Tablet Negative. Given the Step Tablet Negative increment of 0.15 density units, each curve is plotted according to the pattern: RV_1 - Dev_1; RV_2 - Dev_2; RV_3 - Dev_3; RV_n - Dev_n.

Base Curve = 0.10 + gross fog
2nd Curve = 0.10 + gross fog + 0.15
3rd Curve = 0.10 + gross fog + 0.30
*n*th Curve = 0.10 + gross fog + (*n* * density increment)

The upper density limit of the series is determined by the exposure range of the lowest contrast print paper used.

In VIDEC parlance, each curve corresponds to a specific density and is called an Iso-Step. The curves are numbered 1, 2, 3 and so forth with the Base Curve being Iso-Step 1. To make the link between the brightness of an area in the scene and a desired shade of gray in the print, the VIDEC photographer will use the Step Tablet Print. The STP is a print made from the step tablet negative and thus is a portable record of the response of that particular print paper. Each STP step is the visual rendition of a specific negative density when printed under standardized conditions.

Any two shades of gray on a STP can be printed from any two Iso-Steps of the same density interval. To keep overall exposure as low as possible, Iso-Step 1 corresponds to STP Step 1. See the following section for a description of how the STP is made.

VIDEC in Practice

In practice, the photographer measures the scene for the important luminance values (LV). The photographer selects a STP for a print paper based on aesthetic reasons (e.g., base color, image tone, surface qualities, etc.).

For example, a photographer has discovered a scene she wants to photograph. She envisions this scene printed on her favorite warm-tone paper. She retrieves the STP made on the warm-tone paper and evaluates the scene. She determines that she wants to have area q print the same shade of gray as STP Step 8. She must expose the negative so it obtains the density corresponding to Iso-Step 8. For any development time (*m*), she may determine the appropriate exposure (RV) from the eighth iso-density curve. Knowing the luminance (LV) of area q, the value of EV' can be calculated according to the formula:

[6] EV' = LVq – RV (at iso-step 8, development time *m*)

To make a printable negative with the shadow detail she desires, she will also assign a gray value to one more area from the scene, a dark area (area r) that she assigns to STP step 2. Again, area r and the gray assigned are selected for their visual importance in the envisioned photograph.

She then asks, "I need to know the exposure and development for this particular film which will deliver area q as a STP step 8 gray and area r as a STP step 2 gray". To achieve this outcome, the development time must be chosen so that the following condition is met:

[7] EV' = LVq – RV(at iso-step 8)

= LVr – RV(at iso-step 2)

Simultaneous Solution

The iso-density graph can be used as a nomograph and a slide rule to determine both the degree of development and exposure simultaneously. An "LV Ruler" is made to match the divisions of the RV scale on the iso-density graph. To use the nomograph, LVq and LVr are marked off on the LV Ruler. While keeping the LV Ruler parallel to the RV axis, it is positioned so that LVq touches Iso-Step 2 and LVr touches Iso-Step 8. Being careful not to move the ruler, the degree of development m (usually development time in minutes) is read off the intersection of the LV Ruler with the development axis. EV' is read off the LV Ruler where the RV = 0 line intersects. EV' may also be determined by calculation using formula [2].

The nomograph works to determine EV' in the following way. If we assert there is an exposure delivered to the film such that $RV_N = 0$, then:

$EV' = LV_N - RV_N = LV_N - 0$

$EV' = LV_N$

Thus, the value on the LV ruler where the RV = 0 line intersects it is the value for EV'. The photographer selects a combination of AV and TV to equal EV' based on the desired optical effect.

The APEx Numbers

Where T is time in seconds

$$TV = \log_2\left(\frac{1}{T}\right)$$
$$T = 2^{-TV}$$

Where A is the relative aperture in *f*/stops

$$AV = \log_2 A^2$$
$$A = \sqrt{2^{AV}}$$

Where S is the film speed in ISO units when
SV = 0 for S = 100

$$SV = \log_2\left(\frac{S}{100}\right)$$
$$S = 2^{SV} * 100$$

Where B is the surface luminance in candles per square foot and LV = 10 when B = 10 candles per square foot

$$LV = \log_2\left(\frac{B}{10}\right) + 10$$
$$B = 2^{(LV-10)} * 10$$

Where m and F are magnification ratio and filter factor respectively

$$MV = \log_2(1+m) \qquad FV = \log_2$$
$$M = 2^{MV} - 1 \qquad F = 2^{FV}$$

Where t is the transmittance of a lens and I is the illuminance at the film plane in foot candles

$$I = \frac{\pi * t * B}{4 * A\hat{}2 * (1+m)\hat{}2}$$

$$IV = \log_2\left(\frac{4}{\pi} * I\right) + 6.6666 \text{, in I}$$

$$IV = \log_2\left[\frac{\pi * t * B}{4 * A\hat{}2 * (1+m)\hat{}2}\right] + 7 \text{, in t,}$$

Where E is the exposure at the film plane in foot candle seconds

$$E = \frac{\pi * t * B}{4 * A\hat{}2 * (1+m)\hat{}2} * T \text{, in t, B, A, m, T}$$

Where RV is the exposure value at image plane

$$RV = \log_2\left[\frac{\pi * t * B}{4 * A\hat{}2 * (1+m)\hat{}2} * T\right] + 7$$

Appendix

Spot Meter as Transmission Densitometer Using APEx

If you have a decent spot meter, especially one with a digital readout, you can use it as a densitometer using APEx arithmetic. The only thing you need is a stable light source and a supplemental close-up lens. I made a light source from a power supply salvaged from an old computer and connecting a 6 volt halogen flashlight bulb to the 5 volt leads. I put the whole assembly in a box with a translucent plastic cover. The cover diffuses the light from the bulb and provides a convenient place to rest the negative. However, you can use just about any uniform, bright and stable light source, such as a light box, to get good results.

Take a piece of plastic pipe or a cardboard tube and fashion it so it will slip over the front of your spot meter. Paint the inside of the tube flat black. Tape a 10 X diopter close-up lens to it. Cut the roll to a suitable length so the meter provides good focus when you set it on the negative. Mark a 3/8 inch circle on the light source. Place the area of the negative to be read over that spot for each reading.

Densitometers work by measuring the difference between the intensity of the bare light source and the intensity with the negative over the light source. Take two readings. Make the first reading with the negative over the light source and call this

number LVn. Then, without moving the meter, remove the negative and read the light source alone and call this number LVo. Subtract LVn from LVo to obtain the difference we call LVd.

LVd = LVo - LVn.

The formula to convert LVd to optical density units is:

Optical Density = (LVo - LVn) * log 2

If you are handy with math, this formula is easy to solve with a computer spreadsheet.

Ok, if you aren't good at math use the following table. For example; if LVd is 0.7 just look across the table and read that the optical density is 0.21.

LVd	Optical Density	LVd	Optical Density
1.0	0.30	7.0	2.10
0.9	0.27	6.0	1.80
0.8	0.24	5.0	1.50
0.7	0.21	4.0	1.20
0.6	0.18	3.0	0.90
0.5	0.15	2.0	0.60
0.4	0.12	1.0	0.30
0.3	0.09		
0.2	0.06		
0.1	0.03		

Let's do a more complex example. If the LVd is 3.2 then we will take the 3. part of the number and look it up. The result is 0.90. Then look up the 0.2 part of 3.2 and the result is 0.06. Adding 0.90 to 0.06, the result is 0.96 optical density.

APEx for Electronic Flash

The APEx system can be extended to calculate the exposure effect of electronic flash equipment when measured with a reflected-light flash meter. A good flash meter has the ability to measure the intensity of the flash during the pulse of light while ignoring the light from continuous sources.

The flash meter makes its calculations based on the assumption that the flash duration is shorter than the amount of time the shutter is open (TV). Thus, the effect of the shutter speed is null. So, we can drop the term TV from our calculations.

The classic APEx formula is

EV' = AV + TV = LV - SV

For the special case of measuring the luminance of the flash, luminance is notated as LV_f. With TV being null, the term EV does not apply. Thus, the formula can be restated as:

AV' = LV_f + SV

The flash meter can be used indirectly to give LV_f. Most flash meters read out directly in f/stops. With the meter set to ISO 100 (SV = 0), make a reading. The f/stop reading can be converted into AV units using the AV – f/stop conversion table or the formula found at the end of Chapter 14. The AV is equal to LV_f.

Calculating the exposure delivered to the film from flash lighting follows the same pattern. With TV being null, the exposure formula can be simplified to:

RV = LV_f - AV

There are a few things to consider when using flash. Flash duration often varies with the power setting; the higher the power, the longer the duration. The efficiency of leaf shutters decreases as the shutter duration is reduced. As a result, the shutter may not be fully open for the full duration of the flash. Thus, the exposure delivered to the film may be less at a short shutter speed than a longer one.

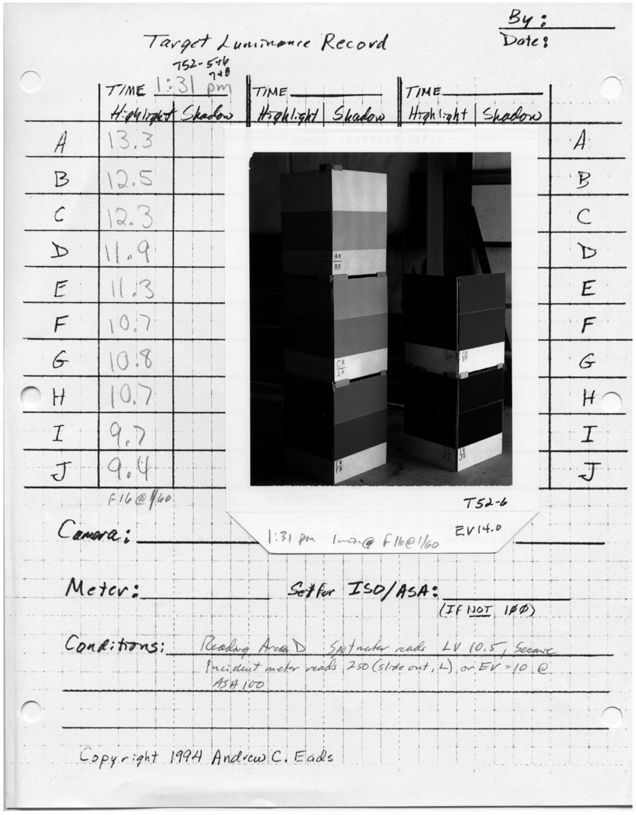
Testing Polaroid T52 Using APEx

I use APEx numbers and formulas extensively when I test films. A good example is a simple test I performed with Polaroid T52 print film.

I like to test films in the same camera I use to take photos. To get a large number of discrete exposures on one sheet of film, I have constructed a target. It is made of hardboard covered with patches of claycoat paper. The paper purchased at an art store comes in shades of gray from a deep black to plain white. I split the board in two and hinged the halves so they form a V-shape. When I perform a test, I arrange them so one side is in shadow and the other in direct light. This arrangement doubles the number of target exposures and increases the difference between the brightest and darkest areas, reducing the quantity of film needed to get a wide range of exposures.

I begin by reading and recording the LV of each target area. Having a helper speeds this up! Then, using the manufacturer's film speed, I establish a baseline exposure. I record the EV' and the actual f/stop and shutter speed, and any other pertinent data.

After processing the exposed T52, I transfer the target and exposure data to a work sheet. Knowing LV for each target area and EV' for each exposure, it is easy to calculate RV for each target. I then read



Target Luminance Record

By:
Date:

T52-5+6
7+8

	TIME 1:31 pm		TIME		TIME		
	Highlight	Shadow	Highlight	Shadow	Highlight	Shadow	
A	13.3						A
B	12.5						B
C	12.3						C
D	11.9						D
E	11.3						E
F	10.7						F
G	10.8						G
H	10.7						H
I	9.7						I
J	9.4						J

F16 @ 1/60

T52-6

EV14.0

1:31 pm 1 min @ f16 @ 1/60

Camera:

Meter: Set for ISO/ASA: (If NOT 100)

Conditions: Reading Area D Spotmeter reads LV 10.5, Secure
Incident meter reads 250 (slide out, L) or EV = 10 @
ASA 100

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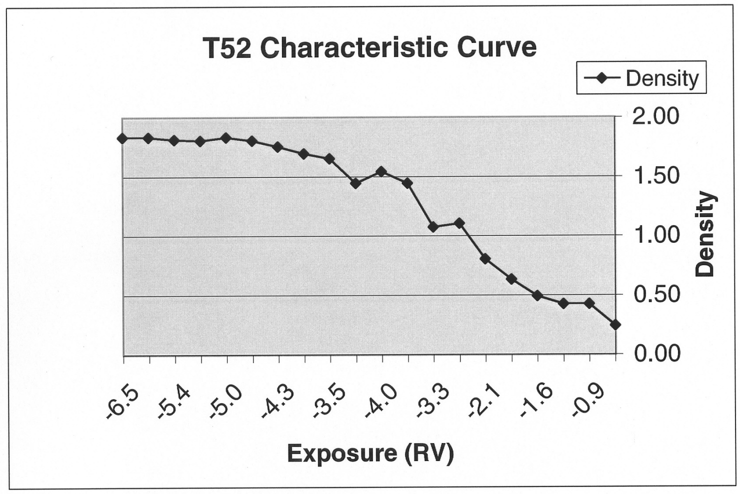
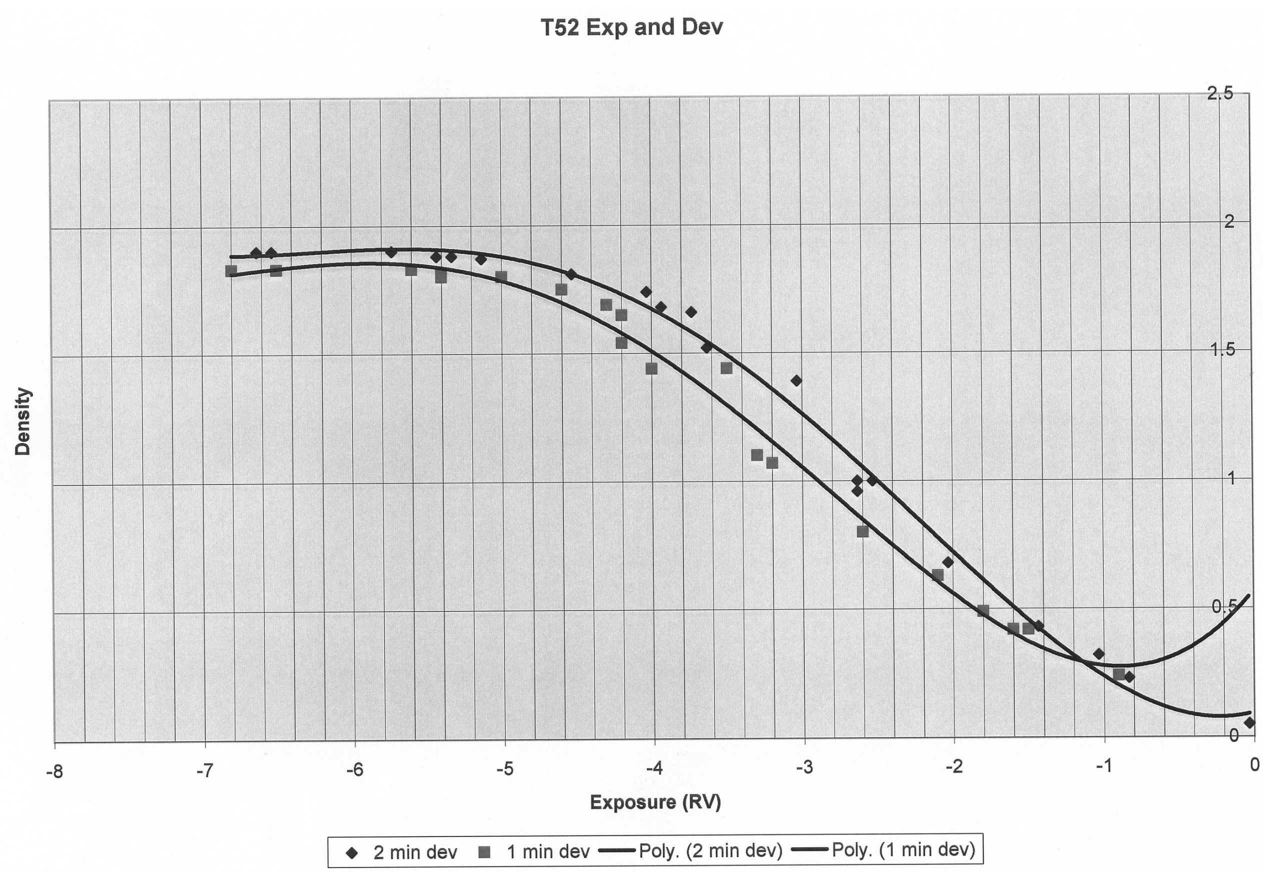
the density of each target area and record on the work sheet the value beside the RV for that area. With this table of data, it is easy to plot the characteristic curve of your film - camera system.

To make this graph especially useful, from the T52 prints, cut out the image of the target patches and paste them on the graph adjacent to their density value. Now you have a way to correlate an object in the scene with a shade of gray on the print with the exact exposure needed. Just measure the value LV from the area of interest, find the value of RV that produces the shade of gray you want, then use these two numbers to calculate EV' (remember, EV' = LV - RV). Choose the combination of f/stop and shutter speed, set the camera and make a perfect exposure.

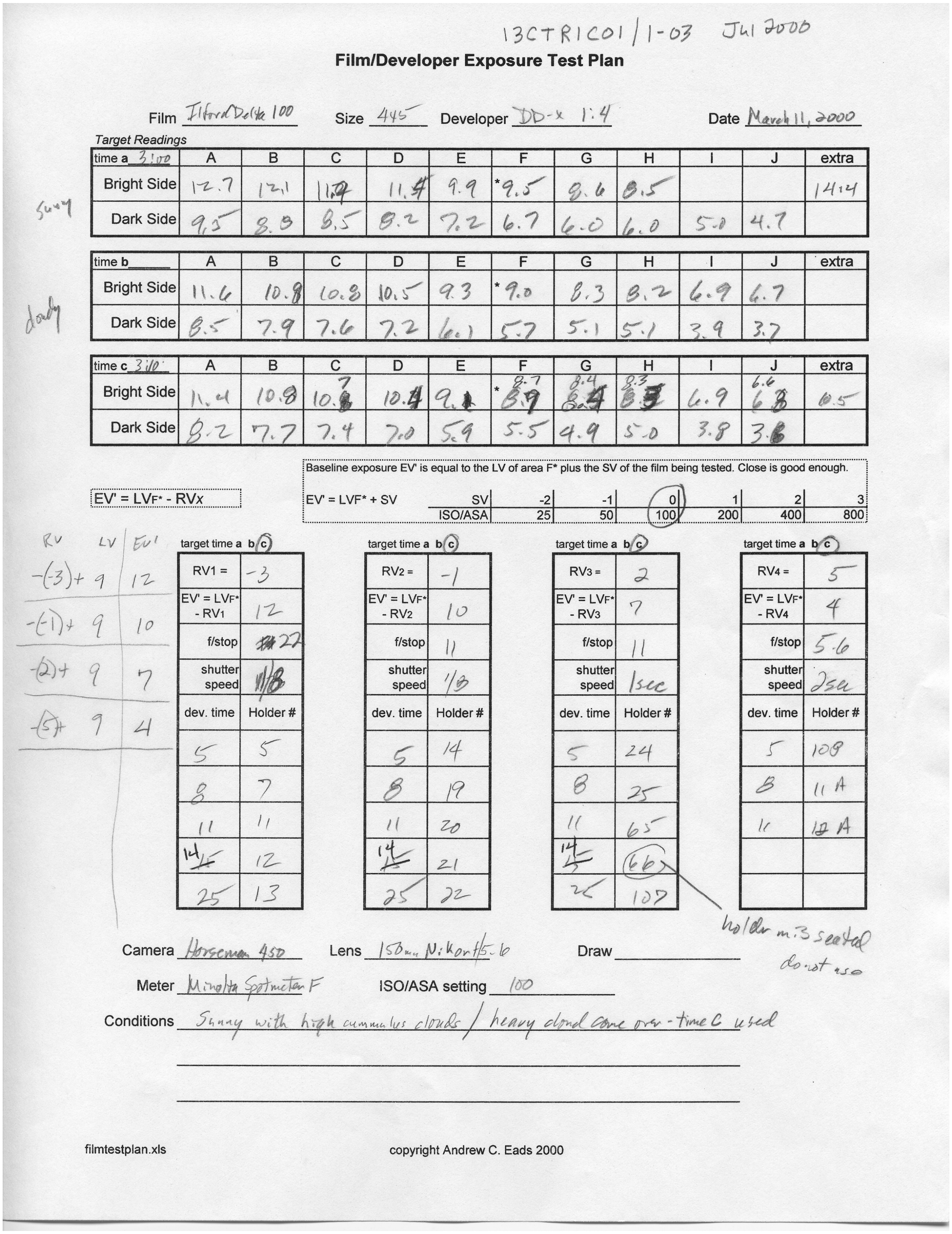
Film Type	Polaroid T 52			**Date**	28-Mar-98
EV'	12.00			**Test ID**	T52-4
Dev Conditions	**Time**	60 sec	**Temp**	65 F	

Target Area		LV	RV	Density
Bright side	A	11.1	-0.9	0.24
	B	10.5	-1.5	0.42
	C	10.4	-1.6	0.42
	D	10.2	-1.8	0.49
	E	9.9	-2.1	0.63
	F	9.4	-2.6	0.80
	G	8.7	-3.3	1.10
	H	8.8	-3.2	1.07
	I	8.0	-4.0	1.44
	J	7.8	-4.2	1.54
Shadow side	A	8.5	-3.5	1.44
	B	7.8	-4.2	1.65
	C	7.7	-4.3	1.69
	D	7.4	-4.6	1.75
	E	7.0	-5.0	1.80
	F	6.4	-5.6	1.83
	G	6.6	-5.4	1.80
	H	6.6	-5.4	1.81
	I	5.5	-6.5	1.83
	J	5.2	-6.8	1.83





Delta 100 4x5 Sheet Film Test



13CTRIC01/1-03 Jul 2000

Film/Developer Exposure Test Plan

Film Ilford Delta 100 Size 4x5 Developer DD-x 1:4 Date March 11, 2000

Target Readings

sunny

time a 3:00	A	B	C	D	E	F	G	H	I	J	extra
Bright Side	12.7	12.1	11.9	11.4	9.9	*9.5	8.6	8.5			14.4
Dark Side	9.5	8.9	8.5	8.2	7.2	6.7	6.0	6.0	5.0	4.7	

cloudy

time b	A	B	C	D	E	F	G	H	I	J	extra
Bright Side	11.6	10.8	10.8	10.5	9.3	*9.0	8.3	8.2	6.9	6.7	
Dark Side	8.5	7.9	7.6	7.2	6.1	5.7	5.1	5.1	3.9	3.7	

time c 3:10	A	B	C	D	E	F	G	H	I	J	extra
Bright Side	11.4	10.8	7 10.8	10.4	9.1	8.7 *8.9	8.4 8.4	8.3 8.5	6.9	6.6 6.8	10.5
Dark Side	8.2	7.7	7.4	7.0	5.9	5.5	4.9	5.0	3.8	3.6	

Baseline exposure EV' is equal to the LV of area F* plus the SV of the film being tested. Close is good enough.

EV' = LVF* + SV	SV	-2	-1	0	1	2	3
	ISO/ASA	25	50	100	200	400	800

EV' = LVF* - RVx

RV	LV	EV'
-(-3)+	9	12
-(-1)+	9	10
-(2)+	9	7
-(5)+	9	4

target time a b c

RV1 =	-3
EV' = LVF* - RV1	12
f/stop	22
shutter speed	1/8
dev. time	Holder #
5	5
8	7
11	11
14	12
25	13

target time a b c

RV2 =	-1
EV' = LVF* - RV2	10
f/stop	11
shutter speed	1/8
dev. time	Holder #
5	14
8	19
11	20
14	21
25	22

target time a b c

RV3 =	2
EV' = LVF* - RV3	7
f/stop	11
shutter speed	1sec
dev. time	Holder #
5	24
8	25
11	65
14	66
25	107

holder mis seated do not use

target time a b c

RV4 =	5
EV' = LVF* - RV4	4
f/stop	5.6
shutter speed	2sec
dev. time	Holder #
5	108
8	11A
11	12A

Camera Horseman 450 Lens 150mm Nikor f/5.6 Draw

Meter Minolta Spotmeter F ISO/ASA setting 100

Conditions Sunny with high cummulus clouds / heavy cloud come over - time C used

filmtestplan.xls

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Delta 100 4x5 Sheet Film Test – Density vs RV for each Development Time

Area	Bright side	Shadow side
A	11.4	8.2
B	10.8	7.7
C	10.7	7.4
D	10.4	7.0
E	9.1	5.9
F	8.7	5.5
G	8.4	4.9
H	8.3	5.0
I	6.9	3.8
J	6.6	3.6

EV' Sequence: 12.0, 10.0, 7.0, 4.0

Ilford Delta 100 dev DD-X 1:4 @ 72 F

Dev. Time = 5.00

Target Area		RV	Density
Bright	A	-0.6	0.55
	B	-1.2	0.47
	C	-1.3	0.47
EV'=	D	-1.6	0.41
12.0	E	-2.9	0.29
	F	-3.3	0.26
dev time	G	-3.6	0.24
5.0	H	-3.7	0.22
	I	-5.1	0.14
	J	-5.4	0.13
Shadow	A	-3.8	0.18
	B	-4.3	0.15
	C	-4.6	0.14
EV'=	D	-5.0	0.13
12.0	E	-6.1	0.11
	F	-6.5	0.11
dev time	G	-7.1	0.11
5.0	H	-7.0	0.11
	I	-8.2	0.11
	J	-8.4	0.11
Bright	A	1.4	0.87
	B	0.8	0.80
	C	0.7	0.78
EV'=	D	0.4	0.72
10.0	E	-0.9	0.54
	F	-1.3	0.51
dev time	G	-1.6	0.47
5.0	H	-1.7	0.45
	I	-3.1	0.30
	J	-3.4	0.27
Shadow	A	-1.8	0.40
	B	-2.3	0.33
	C	-2.6	0.31
	D	-3.0	0.27
EV'=	E	-4.1	0.19
10.0	F	-4.5	0.17
	G	-5.1	0.14
dev time	H	-5.0	0.13
5.0	I	-6.2	0.11
	J	-6.4	0.11
Bright	A	4.4	1.27
	B	3.8	1.19
	C	3.7	1.19
EV'=	D	3.4	1.12
7.0	E	2.1	0.93
	F	1.7	0.89
dev time	G	1.4	0.85
5.0	H	1.3	0.82
	I	-0.1	0.63
	J	-0.4	0.60
Shadow	A	1.2	0.78
	B	0.7	0.70
	C	0.4	0.68
	D	0.0	0.62
EV'=	E	-1.1	0.48
7.0	F	-1.5	0.43
	G	-2.1	0.37
dev time	H	-2.0	0.37
5.0	I	-3.2	0.26
	J	-3.4	0.23
Bright	A	7.4	1.53
	B	6.8	1.50
	C	6.7	1.50
EV'=	D	6.4	1.44
4.0	E	5.1	1.33
	F	4.7	1.31
dev time	G	4.4	1.25
5.0	H	4.3	1.23
	I	2.9	0.99
	J	2.6	0.95
Shadow	A	4.2	1.26
	B	3.7	1.09
	C	3.4	1.05
	D	3.0	0.99
EV'=	E	1.9	0.85
4.0	F	1.5	0.80
	G	0.9	0.72
dev time	H	1.0	0.70
5.0	I	-0.2	0.53
	J	-0.4	0.49

Dev. Time = 8.00

Target Area		RV	Density
Bright	A	-0.6	0.74
	B	-1.2	0.65
	C	-1.3	0.63
EV'=	D	-1.6	0.55
12.0	E	-2.9	0.37
	F	-3.3	0.34
dev time	G	-3.6	0.31
8.0	H	-3.7	0.30
	I	-5.1	0.18
	J	-5.4	0.17
Shadow	A	-3.8	0.24
	B	-4.3	0.20
	C	-4.6	0.16
EV'=	D	-5.0	0.17
12.0	E	-6.1	0.14
	F	-6.5	0.14
dev time	G	-7.1	0.14
8.0	H	-7.0	0.14
	I	-8.2	0.14
	J	-8.4	0.14
Bright	A	1.4	1.17
	B	0.8	1.06
	C	0.7	1.04
EV'=	D	0.4	0.96
10.0	E	-0.9	0.71
	F	-1.3	0.68
dev time	G	-1.6	0.62
8.0	H	-1.7	0.59
	I	-3.1	0.40
	J	-3.4	0.35
Shadow	A	-1.8	0.53
	B	-2.3	0.45
	C	-2.6	0.41
	D	-3.0	0.36
EV'=	E	-4.1	0.24
10.0	F	-4.5	0.21
	G	-5.1	0.18
dev time	H	-5.0	0.18
8.0	I	-6.2	0.13
	J	-6.4	0.13
Bright	A	4.4	1.72
	B	3.8	1.62
	C	3.7	1.59
EV'=	D	3.4	1.53
7.0	E	2.1	1.30
	F	1.7	1.26
dev time	G	1.4	1.19
8.0	H	1.3	1.16
	I	-0.1	0.89
	J	-0.4	0.84
Shadow	A	1.2	1.11
	B	0.7	1.00
	C	0.4	0.96
	D	0.0	0.89
EV'=	E	-1.1	0.68
7.0	F	-1.5	0.61
	G	-2.1	0.52
dev time	H	-2.0	0.52
8.0	I	-3.2	0.36
	J	-3.4	0.32
Bright	A	7.4	2.09
	B	6.8	2.03
	C	6.7	2.03
EV'=	D	6.4	1.96
4.0	E	5.1	1.79
	F	4.7	1.77
dev time	G	4.4	1.69
8.0	H	4.3	1.66
	I	2.9	1.37
	J	2.6	1.31
Shadow	A	4.2	1.56
	B	3.7	1.49
	C	3.4	1.45
	D	3.0	1.37
EV'=	E	1.9	1.20
4.0	F	1.5	1.13
	G	0.9	1.02
dev time	H	1.0	0.99
8.0	I	-0.2	0.76
	J	-0.4	0.70

Dev. Time = 11.00

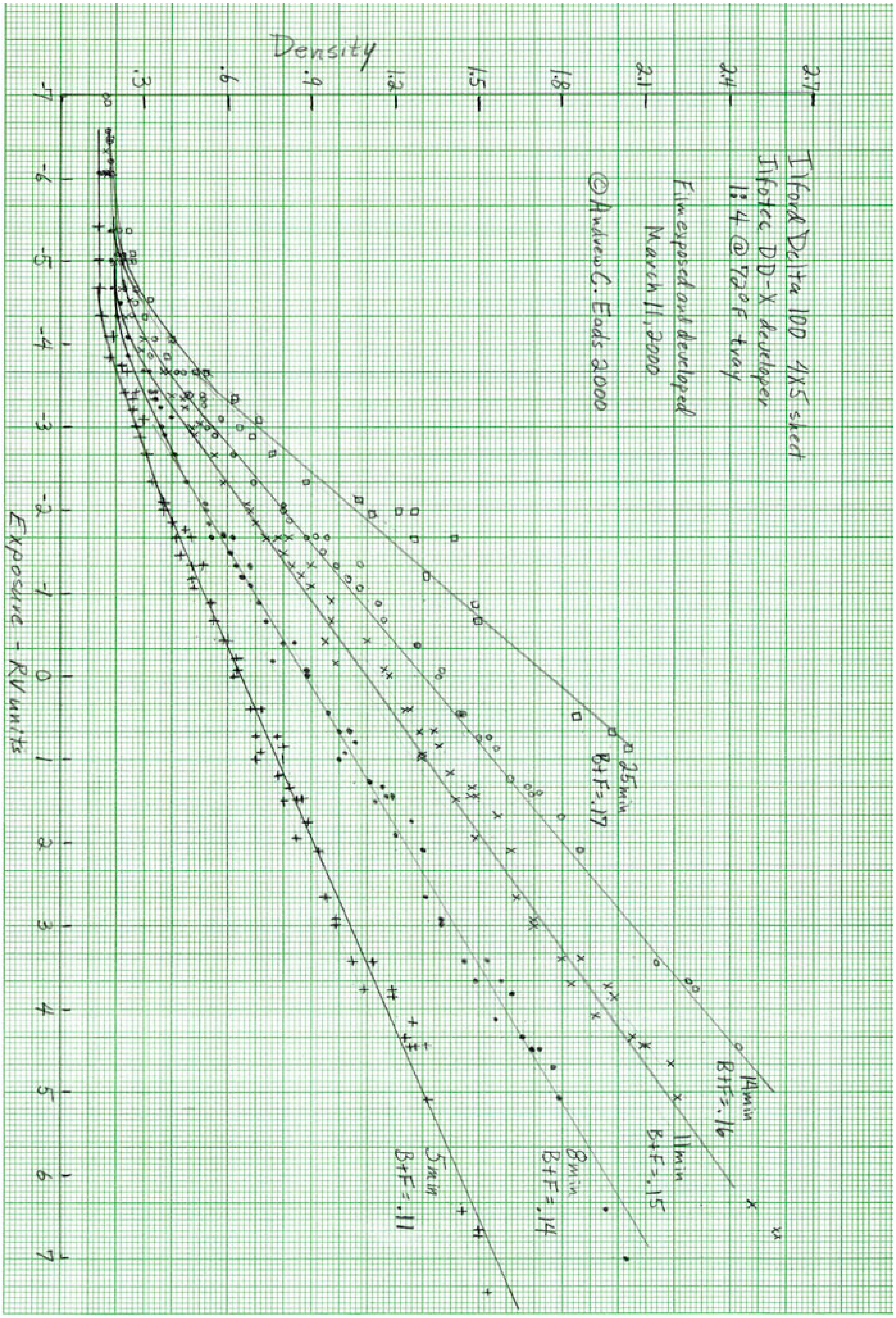
Target Area		RV	Density
Bright	A	-0.6	0.97
	B	-1.2	0.88
	C	-1.3	0.83
EV'=	D	-1.6	0.74
12.0	E	-2.9	0.48
	F	-3.3	0.44
dev tim	G	-3.6	0.39
11.0	H	-3.7	0.37
	I	-5.1	0.21
	J	-5.4	0.19
Shadow	A	-3.8	0.29
	B	-4.3	0.23
	C	-4.6	0.22
EV'=	D	-5.0	0.19
12.0	E	-6.1	0.16
	F	-6.5	0.16
dev tim	G	-7.1	0.15
11.0	H	-7.0	0.15
	I	-8.2	0.14
	J	-8.4	0.14
Bright	A	1.4	1.47
	B	0.8	1.36
	C	0.7	1.34
EV'=	D	0.4	1.25
10.0	E	-0.9	0.97
	F	-1.3	0.90
dev tim	G	-1.6	0.82
11.0	H	-1.7	0.78
	I	-3.1	0.50
	J	-3.4	0.46
Shadow	A	-1.8	0.70
	B	-2.3	0.58
	C	-2.6	0.55
	D	-3.0	0.47
EV'=	E	-4.1	0.30
10.0	F	-4.5	0.25
	G	-5.1	0.20
dev tim	H	-5.0	0.20
11.0	I	-6.2	0.16
	J	-6.4	0.15
Bright	A	4.4	2.10
	B	3.8	1.99
	C	3.7	1.97
EV'=	D	3.4	1.87
7.0	E	2.1	1.62
	F	1.7	1.57
dev tim	G	1.4	1.49
11.0	H	1.3	1.48
	I	-0.1	1.17
	J	-0.4	1.10
Shadow	A	1.2	1.40
	B	0.7	1.29
	C	0.4	1.24
	D	0.0	1.18
EV'=	E	-1.1	0.90
7.0	F	-1.5	0.80
	G	-2.1	0.67
dev tim	H	-2.0	0.68
11.0	I	-3.2	0.45
	J	-3.4	0.40
Bright	A	7.4	2.62
	B	6.8	2.57
	C	6.7	2.57
EV'=	D	6.4	2.48
4.0	E	5.1	2.21
	F	4.7	2.19
dev tim	G	4.4	2.09
11.0	H	4.3	2.05
	I	2.9	1.70
	J	2.6	1.63
Shadow	A	4.2	1.93
	B	3.7	1.83
	C	3.4	1.80
	D	3.0	1.70
EV'=	E	1.9	1.49
4.0	F	1.5	1.42
	G	0.9	1.30
dev tim	H	1.0	1.30
11.0	I	-0.2	0.99
	J	-0.4	0.91

Dev. Time = 14.00

Target Area		RV	Density
Bright	A	-0.6	1.16
	B	-1.2	1.03
	C	-1.3	0.99
EV'=	D	-1.6	0.87
12.0	E	-2.9	0.55
	F	-3.3	0.51
dev tim	G	-3.6	0.44
14.0	H	-3.7	0.41
	I	-5.1	0.23
	J	-5.4	0.21
Shadow	A	-3.8	0.32
	B	-4.3	0.26
	C	-4.6	0.23
EV'=	D	-5.0	0.21
12.0	E	-6.1	0.17
	F	-6.5	0.16
dev tim	G	-7.1	0.16
14.0	H	-7.0	0.16
	I	-8.2	0.16
	J	-8.4	0.16
Bright	A	1.4	1.69
	B	0.8	1.57
	C	0.7	1.54
EV'=	D	0.4	1.44
10.0	E	-0.9	1.14
	F	-1.3	1.08
dev tim	G	-1.6	0.96
14.0	H	-1.7	0.92
	I	-3.1	0.58
	J	-3.4	0.51
Shadow	A	-1.8	0.82
	B	-2.3	0.69
	C	-2.6	0.62
	D	-3.0	0.52
EV'=	E	-4.1	0.34
10.0	F	-4.5	0.28
	G	-5.1	0.22
dev tim	H	-5.0	0.22
14.0	I	-6.2	0.17
	J	-6.4	0.16
Bright	A	4.4	2.43
	B	3.8	2.28
	C	3.7	2.25
EV'=	D	3.4	2.14
7.0	E	2.1	1.87
	F	1.7	1.80
dev tim	G	1.4	1.72
14.0	H	1.3	1.68
	I	-0.1	1.37
	J	-0.4	1.28
Shadow	A	1.2	1.61
	B	0.7	1.50
	C	0.4	1.43
	D	0.0	1.36
EV'=	E	-1.1	1.07
7.0	F	-1.5	0.95
	G	-2.1	0.80
dev tim	H	-2.0	0.80
14.0	I	-3.2	0.51
	J	-3.4	0.46
Bright	A	7.4	
	B	6.8	
	C	6.7	
EV'=	D	6.4	
4.0	E	5.1	
	F	4.7	
dev tim	G	4.4	
14.0	H	4.3	
	I	2.9	
	J	2.6	
Shadow	A	4.2	
	B	3.7	
	C	3.4	
	D	3.0	
EV'=	E	1.9	
4.0	F	1.5	
	G	0.9	
dev tim	H	1.0	
14.0	I	-0.2	
	J	-0.4	

Dev. Time = 25.00

Target Area		RV	Density
Bright	A	-0.6	1.50
	B	-1.2	1.32
	C	-1.3	1.26
EV'=	D	-1.6	1.10
12.0	E	-2.9	0.68
	F	-3.3	0.62
dev tim	G	-3.6	0.53
25.0	H	-3.7	0.49
	I	-5.1	0.26
	J	-5.4	0.24
Shadow	A	-3.8	0.36
	B	-4.3	0.30
	C	-4.6	0.27
EV'=	D	-5.0	0.24
12.0	E	-6.1	0.18
	F	-6.5	0.18
dev tim	G	-7.1	0.17
-25.0	H	-7.0	0.17
	I	-8.2	0.17
	J	-8.4	0.17
Bright	A	1.4	2.20
	B	0.8	2.04
	C	0.7	1.98
EV'=	D	0.4	1.85
10.0	E	-0.9	1.48
	F	-1.3	1.41
dev tim	G	-1.6	1.27
25.0	H	-1.7	1.21
	I	-3.1	0.72
	J	-3.4	0.63
Shadow	A	-1.8	1.07
	B	-2.3	0.88
	C	-2.6	0.77
	D	-3.0	0.64
EV'=	E	-4.1	0.40
10.0	F	-4.5	0.33
	G	-5.1	0.26
dev tim	H	-5.0	0.26
25.0	I	-6.2	0.19
	J	-6.4	0.19
Bright	A	4.4	
	B	3.8	
	C	3.7	
EV'=	D	3.4	
7.0	E	2.1	
	F	1.7	
dev tim	G	1.4	
25.0	H	1.3	
	I	-0.1	
	J	-0.4	
Shadow	A	1.2	
	B	0.7	
	C	0.4	
	D	0.0	
EV'=	E	-1.1	
7.0	F	-1.5	
	G	-2.1	
dev tim	H	-2.0	
25.0	I	-3.2	
	J	-3.4	
Bright	A	7.4	
	B	6.8	
	C	6.7	
EV'=	D	6.4	
4.0	E	5.1	
	F	4.7	
dev tim	G	4.4	
25.0	H	4.3	
	I	2.9	
	J	2.6	
Shadow	A	4.2	
	B	3.7	
	C	3.4	
	D	3.0	
EV'=	E	1.9	
4.0	F	1.5	
	G	0.9	
dev tim	H	1.0	
25.0	I	-0.2	
	J	-0.4	


Density
.3
.6
.9
1.2
1.5
1.8
2.1
2.4
2.7
Ilford Delta 100 4X5 sheet
Ilfotec DD-X developer
1:4 @ 72°F tray
Film exposed and developed
March 11, 2000
©Andrew C. Eads 2000
25min B+F=.17
14min B+F=.16
11min B+F=.15
8min B+F=.14
5min B+F=.11
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
Exposure - RV units

base EPD	0.1
stn interval	0.15

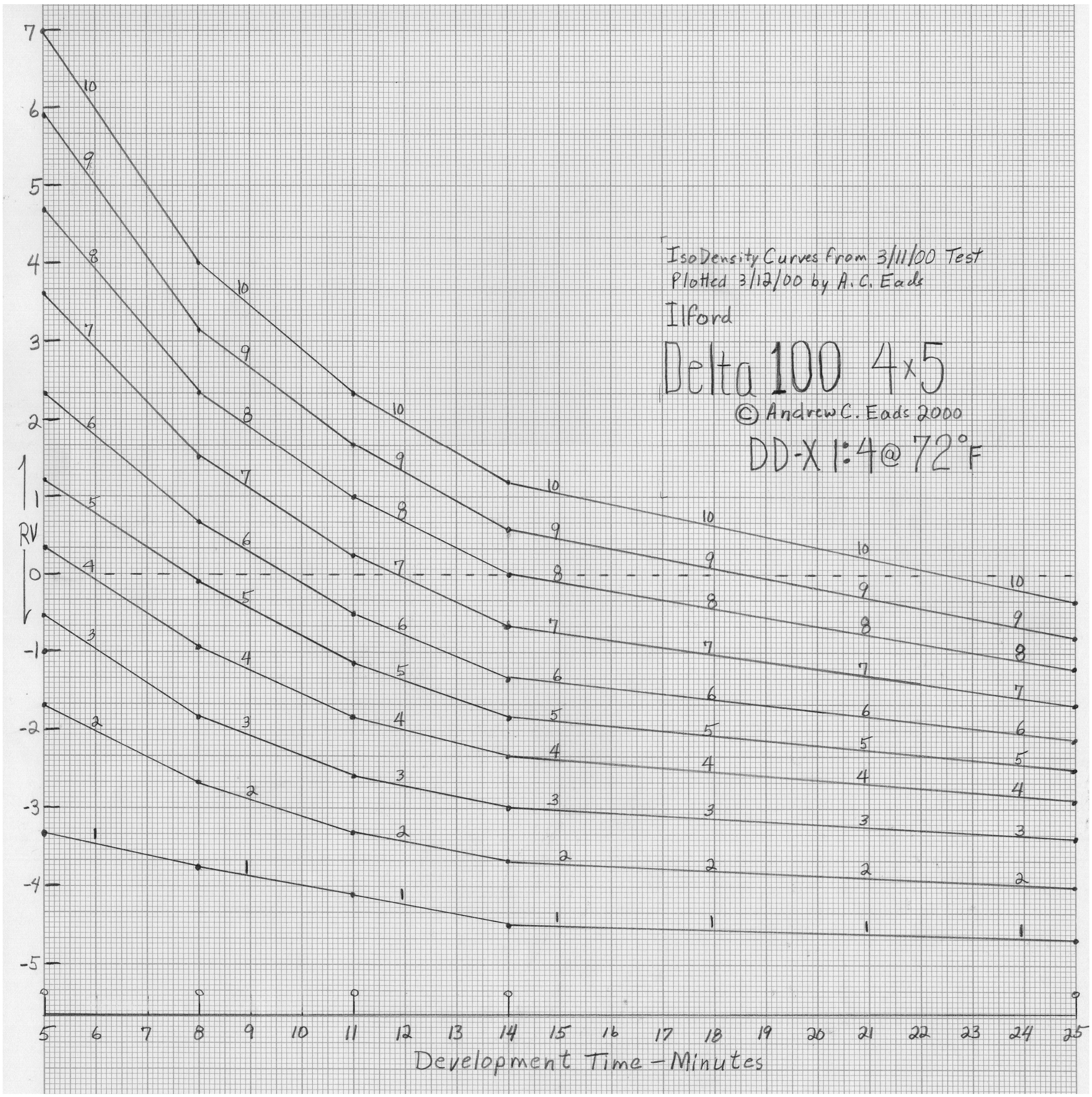
VIDEC Iso-density Graph Worksheet

Ilford Delta 100 4X5 Sheet
Ilfotec DD-X 1:4 72°F Tray
3/11/00 Test

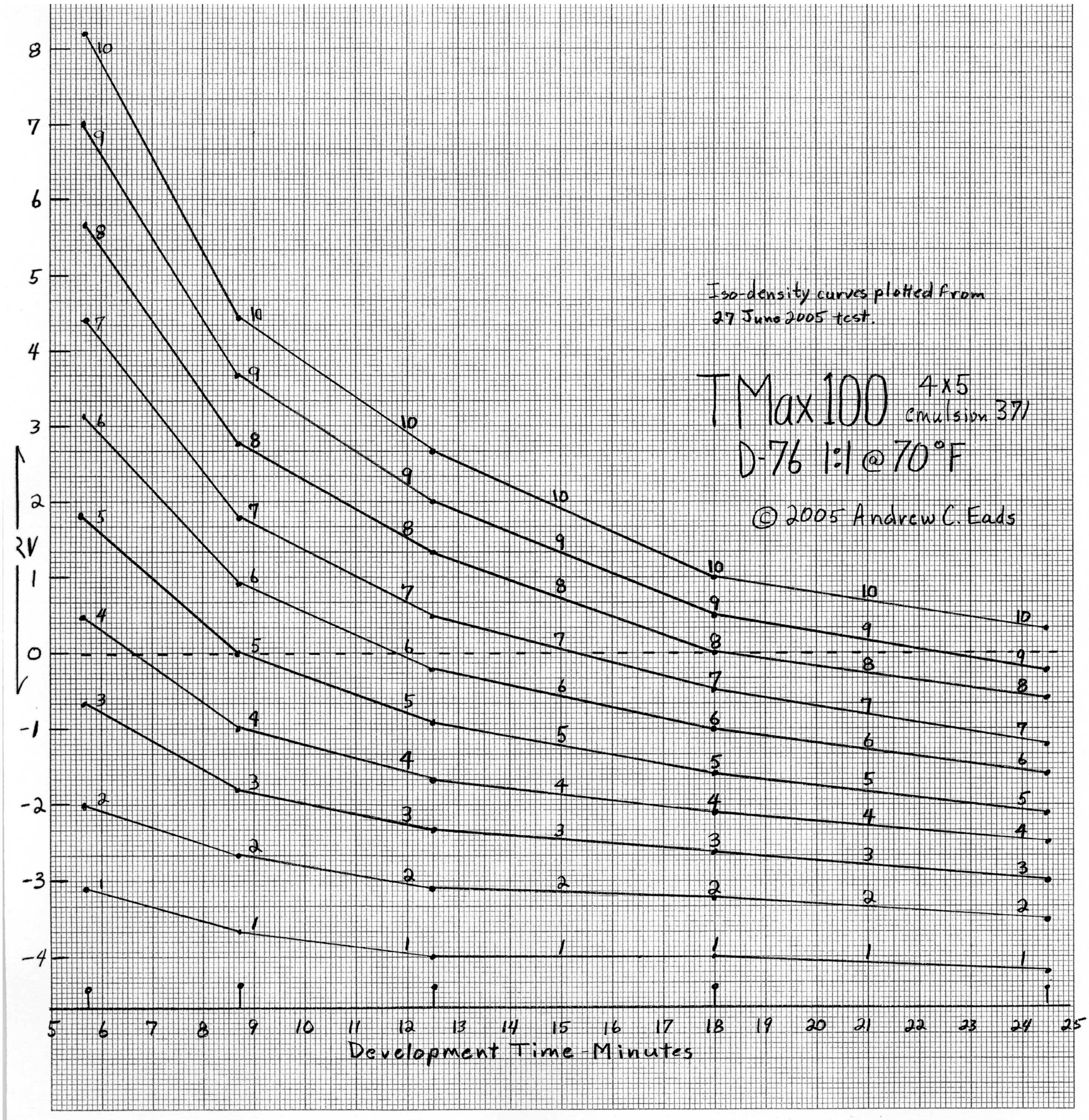
dev time	5		8		11		14		25	
base+fog	0.11		0.14		0.15		0.16		0.17	
	density	RV		RV		RV		RV		RV
step 1	0.21	-3.66	0.24	-4.0	0.25	-4.1	0.26	-4.4	0.27	-4.7
step 2	0.36	-2.1	0.39	-2.8	0.40	-3.3	0.41	-3.6	0.42	-4.1
step 3	0.51	-1.1	0.54	-1.9	0.55	-2.5	0.56	-3.0	0.57	-3.4
step 4	0.66	0.0	0.69	-1.1	0.70	-1.9	0.71	-2.4	0.72	-3.0
step 5	0.81	1.2	0.84	-.3	0.85	-1.1	0.86	-1.8	0.87	-2.5
step 6	0.96	2.33	0.99	.5	1.00	-.5	1.01	-1.2	1.02	-2.1
step 7	1.11	3.5	1.14	1.4	1.15	.2	1.16	-.6	1.17	-1.6
step 8	1.26	4.5	1.29	2.3	1.30	.9	1.31	0.0	1.32	-1.2
step 9	1.41	5.7	1.44	3.1	1.45	1.6	1.46	.6	1.47	-.8
step 10	1.56	7.0	1.59	4.0	1.60	2.3	1.61	1.2	1.62	-.4
step 11	1.71		1.74	4.8	1.75	3.1	1.76	1.8	1.77	0.0
step 12	1.86		1.89	5.6	1.90	3.7	1.91	2.4	1.92	.4

$\Delta RV_2^{10} = 9.1$ 6.8 5.6 4.8 4.3

Delta 100 4x5 Sheet Film Test – Iso-density Graph



T Max 100 4x5 Sheet Film Test – Iso-density Graph



APEx Conversion Tables

The VIDEC System

APEx Values for AV, TV, and SV

1/2 stop

f/stop	AV
1.0	0.0
1.2	0.5
1.4	1.0
1.7	1.5
2.0	2.0
2.4	2.5
2.8	3.0
3.4	3.5
4.0	4.0
4.8	4.5
5.7	5.0
6.7	5.5
8.0	6.0
9.5	6.5
11.3	6.9
13.5	7.5
16.0	8.0
19.0	8.5
22.6	8.9
26.9	9.5
32.0	10.0
38.1	10.5
45.3	11.0
53.8	11.5
64.0	12.0

1/3 stop

f/stop	AV
1.0	0.0
1.1	0.3
1.3	0.7
1.4	1.0
1.6	1.3
1.8	1.7
2.0	2.0
2.2	2.3
2.5	2.7
2.8	3.0
3.2	3.3
3.6	3.7
4.0	4.0
4.5	4.3
5.0	4.7
5.7	5.0
6.3	5.3
7.1	5.7
8.0	6.0
9.0	6.3
10.1	6.7
11.3	7.0
12.7	7.3
14.3	7.7
16.0	8.0
18.0	8.3
20.2	8.7
22.6	9.0
25.4	9.3
28.5	9.7
32.0	10.0
35.9	10.3
40.3	10.7
45.3	11.0
50.8	11.3
57.0	11.7
64.0	12.0

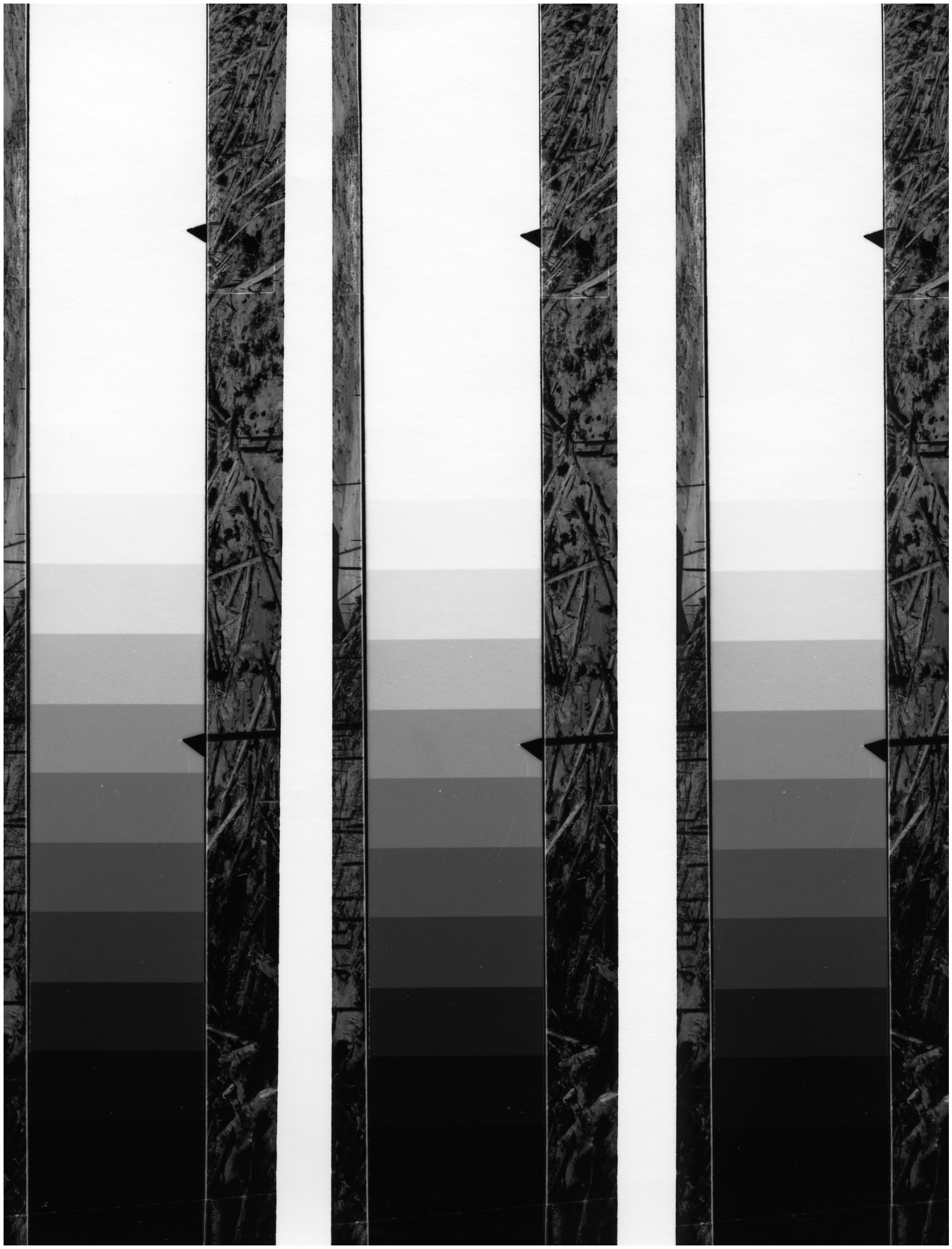
whole stop

time	TV
512	-9
256	-8
128	-7
64	-6
32	-5
16	-4
8	-3
4	-2
2	-1
1	0
1/2	1
1/4	2
1/8	3
1/15	4
1/30	5
1/60	6
1/125	7
1/250	8
1/500	9
1/1000	10
1/2000	11
1/4000	12
1/8000	13

1/3 stop

ISO/EV	SV
6	-4.0
4	-4.7
5	-4.3
6	-4.0
8	-3.7
10	-3.3
13	-3.0
16	-2.7
20	-2.3
25	-2.0
31	-1.7
40	-1.3
50	-1.0
63	-0.7
79	-0.3
100	0.0
126	0.3
159	0.7
200	1.0
252	1.3
317	1.7
400	2.0
504	2.3
635	2.7
800	3.0
1008	3.3
1270	3.7
1600	4.0
2016	4.3
2540	4.7
3200	5.0

AV TV SV table.xls



Due to limitations of the reproduction process, these are not perfect representations of the originals. It is left to you to make your own step tablet print on each paper you use. See Chapter 10.

The originals of the above step tablet prints were printed from a Kodak #2 Step Tablet Negative (0.15 density increment) by enlargement with a condenser light source with a #2 filter onto Ilford MultiGrade Fiber Base Glossy paper.

Index

Symbols

A

B

C

D

E

F

G

H

Worksheets

The worksheets on the following pages may be reproduced for your personal use only. Feel free to create your own worksheets or adapt these to fit your needs.

The VIDEC System

Film Test Checklist

Date Prepared: ______________________________
Prepared by: ______________________________

Film Name: ______________________________
Size: ______________________________
Emulsion Number: ______________________________
Expiration Date: ______________________________
Manufacturer's Film Speed: ______________________________

Developer Chosen: ______________________________
Dilution Ratio: ______________________________
Temperature: ______________________________
Agitation technique: ______________________________
Tank, tray, tube? ______________________________

Film Test Name: ______________________________ ➲

Film Speed Chosen for this Test: _______________
SV = _______________ ➲

Development Time Range (in minutes) - choose best range of five times: 4 5.5 8 11 16 22 32 ➲

Light Meter (make & model): ______________________________
Camera (make & model): ______________________________
Lens (name, focal length, f/stop): ______________________________
Lens Hood? ______________________________

Target Type: Single Area Multi Area
Distance to Target: ______________________________
Location: ______________________________
Camera Orientation: ______________________________

Best Time of Day to Perform Test: ______________________________

Anticipated Lighting:

Direct Sun	Tungsten	Vapor
Open Sky	Fluorescent	Other
Deep Shade	HMI	

Transfer items marked ➲ to Target Test Plan

Single Target Test Record

VIDEC Film Test Name: ______________________________

Exp Range	EV (= EV' + ExpRange)	AV (From AV Table)	TV (Calculate TV = EV - AV)	Frame #	f/stop (From Lens)	time (From TV Table)
+ 6.0				1		
+ 5.5				2		
+ 5.0				3		
+ 4.5				4		
+ 4.0				5		
+ 3.5				6		
+ 3.0				7		
+ 2.5				8		
+ 2.0				9		
+ 1.5				10		
+ 1.0				11		
+ 0.5				12		
+ 0 →				13		
- 1.0				14		
- 2.0				15		
- 3.0				16		
- 4.0				17		
- 5.0				18		
			Use these frames	19		
			to identify this roll	20		
			and Dev. Time.	21		

Focal Length:	
Min. Aperture:	
Max. Aperture:	
Date:	
Time:	
Film:	
Camera:	
Target Distance:	

Target Reading	LV	
Film Speed in SV	+SV	
	= EV	
Rounded Down	**EV'**	→

Notes:

____

____

____

____

____

____

ISO/EV	SV
25	-2.0
31	-1.7
40	-1.3
50	-1.0
63	-0.7
79	-0.3
100	0.0
126	0.3
159	0.7
200	1.0
252	1.3
317	1.7
400	2.0
504	2.3
635	2.7
800	3.0
1008	3.3
1270	3.7
1600	4.0
2016	4.3
2540	4.7

AV = EV - TV

f/stop	AV
1.4	1.0
1.7	1.5
2.0	2.0
2.4	2.5
2.8	3.0
3.4	3.5
4.0	4.0
4.8	4.5
5.6	5.0
6.7	5.5
8.0	6.0
9.5	6.5
11.0	7.0
13.5	7.5
16.0	8.0
19.0	8.5
22.0	9.0
26.9	9.5
32.0	10.0
38.1	10.5
45.0	11.0

TV = EV - AV

time	TV
128.0	-7.0
64.0	-6.0
32.0	-5.0
16.0	-4.0
8.0	-3.0
4.0	-2.0
2.0	-1.0
1.0	0.0
1/2	1.0
1/4	2.0
1/8	3.0
1/15	4.0
1/30	5.0
1/60	6.0
1/125	7.0
1/250	8.0
1/500	9.0
1/1000	10.0
1/2000	11.0
1/4000	12.0
1/8000	13.0

Film ______________ Date Processed ____________

Developer ______________ Dilution ____________ Temp _______

Development Time:				
Exp #	LV	- EV	= RV	Density
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Development Time:				
Exp #	LV	- EV	= RV	Density
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				

Notes:

The VIDEC System

Multi-Area Target Test Record

VIDEC Film Test Name: ______________________________

Target Luminance Readings (in LV units - Set Light Meter to ISO 100)

Primary

time **a**______	A	B	C	D	E	F	G	H	I	J	extra
Bright Side						*					
Dark Side											

Secondary

time **b**______	A	B	C	D	E	F	G	H	I	J	extra
Bright Side						*					
Dark Side											

Secondary

time **c**______	A	B	C	D	E	F	G	H	I	J	extra
Bright Side						*					
Dark Side											

Calculation of EV'

*Area F * Bright Side Reading*	LVF*	
From ISO/SV Table	+ SV	
	= EV	
Round to nearest whole number	**EV'**	

ISO/SV Table

SV	-1	0	+1	+2	+3
ISO or EI	50	100	200	400	800

Exposure Blocks

target time **a b c**

EV'		**EV'**		**EV'**		**EV'**		
Exp. Range	+ 4	Exp. Range	+ 2	Exp. Range	- 2	Exp. Range	- 6	
EV'1		**EV'2**		**EV'3**		**EV'4**		
f/stop		f/stop		f/stop		f/stop		
shutter speed		shutter speed		shutter speed		shutter speed		
	Holder #		Holder #		Holder #		Holder #	Development Times
time 1		time 1		time 1		time 1		
time 2		time 2		time 2		time 2		
time 3		time 3		time 3		time 3		
time 4		time 4		time 4		time 4		
time 5		time 5		time 5		time 5		

^^Roll Film - Expose across by times^^

>>Sheet film - Expose by column, top to bottom>>

Reference Table: Shutter Speed to TV, *f* /stop to AV EV' = AV + TV

Shutter Speed	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000
TV or AV	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
f/stop		1.0	1.4	2.0	2.8	4.0	5.6	8.0	11.0	16.0	22.0	32.0

Multi Target RV Density Worksheet

Film Test Name: ____________________

Dev. Time ____________

EV' ____________

Target Area		LV	- EV'	= RV	Density
Bright	A				
Bright	B				
Bright	C				
Bright	D				
Bright	E				
Bright	F				
Bright	G				
Bright	H				
Bright	I				
Bright	J				
Shadow	A				
Shadow	B				
Shadow	C				
Shadow	D				
Shadow	E				
Shadow	F				
Shadow	G				
Shadow	H				
Shadow	I				
Shadow	J				

Dev. Time ____________

EV' ____________

Target Area		LV	- EV'	= RV	Density
Bright	A				
Bright	B				
Bright	C				
Bright	D				
Bright	E				
Bright	F				
Bright	G				
Bright	H				
Bright	I				
Bright	J				
Shadow	A				
Shadow	B				
Shadow	C				
Shadow	D				
Shadow	E				
Shadow	F				
Shadow	G				
Shadow	H				
Shadow	I				
Shadow	J				

Iso-Density Graph Worksheet

Base EPD ________ STN Density Interval ________ Film Test Name: ____________________

dev time										
base+fog										
	density	RV		RV		RV		RV		RV
step 1										
step 2										
step 3										
step 4										
step 5										
step 6										
step 7										
step 8										
step 9										
step 10										
step 11										
step 12										
step 13										
step 14										
step 15										
step 16										
step 17										
step 18										
step 19										
step 20										

The VIDEC System
VIDEC Exposure Record Version 9

STP: IMGFB 2 ______
IMGWarm2 ______

Neg File #: ______

Developed: ______

AV	*f* / stop	TV	Time
1	**1.4**	**10**	**1/1000**
1.3	1.6	*	*
1.7	1.8	*	*
2	**2**	**9**	**1/500**
2.3	2.2	*	1/400
2.7	2.5	*	*
3	**2.8**	**8**	**1/250**
3.3	3.2	*	1/200
3.7	3.6	*	*
4	**4**	**7**	**1/125**
4.3	4.5	*	1/100
4.7	5	*	*
5	**5.6**	**6**	**1/60**
5.3	6.3	*	1/50
5.7	7.1	*	*
6	**8**	**5**	**1/30**
6.3	9	*	1/25
6.7	10.1	*	*
7	**11**	**4**	**1/15**
7.3	12.7	*	*
7.7	14.3	*	1/10
8	**16**	**3**	**1/8**
8.3	18	*	*
8.7	20.2	*	1/5
9	**22**	**2**	**1/4**
9.3	25.4	*	*
9.7	28.5	*	*
10	**32**	**1**	**1/2**
10.3	35.9	*	*
10.7	40.3	*	*
11	**45**	**0.0**	**1** ↓
11.3	50.8	-0.3	1.3 ↓
11.7	57	-0.7	1.6 ↓
12	**64**	**-1.0**	**2** ↓
12.3	71.8	-1.3	2.5 r
12.7	80.6	-1.7	3.2 e
13	**90**	**-2.0**	**4** c
AV	*f* / stop	-2.3	5 i
		-2.7	6.3 p
		-3.0	**8** r
		-3.3	10 o
		-3.7	13 s
		-4.0	**16** i
		-4.3	20 t
		-4.7	25 y
		-5.0	**32** ↓
		-5.3	40 ↓
		-5.7	51 ↓
		-6.0	**64** ↓
		TV	Time

I-D graph: Delta100/DDX, Delta400/DDX, HP-5/DDX, BPF/D76, TMax100/HC110, TMax400/HC110, 100Tmax / D76 1:1, ______

	Set 1	Set 2
Focal Length		
Extention		
EV' =		
FV =	-	-
MV =	-	-
compensated **EV' =**		
Holder #		
Holder #		
Holder #		
Holder #		

Subject

Location

Date / Time

Camera

Lens

Movements - Bellows Draw

Notes

N

Camera Orientation

19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1

Development Time - minutes

5 . 6 . 7 . 8 . 9 . 10 . 11 . 12 . 13 . 14 . 15 . 16 . 17 . 18 . 19 . 20 . 21 . 22 . 23 . 24 . 25

About the Author

Andrew Eads is involved in the photographic community as a photographer, author and educator.

His passion for fine black and white photography, combined with his technical expertise, led him to devise the unique exposure control system called VIDEC. His fine art black and white photographs include landscapes, portraits, and abstract images. Using large-format cameras, his finely detailed photographs are noted for their rich tonality.

For nearly 20 years, Mr. Eads was a senior photographer at a major government facility. Mr. Eads has also taught at Columbia Basin College, operated his own digital imaging business and recently established a career-oriented photography program serving nearly 300 high school students yearly. He has authored several articles on photographic technique and color management appearing in publications such as Photo Techniques and Big Picture.

Recognized by the Professional Photographers of America, Eastman Kodak, and the American Society of Photographers, his photographs have appeared in Studio Light, The Professional Photographer, and many scientific journals. Mr. Eads holds a Bachelor of Arts degree in Scientific/Industrial Photography from Brooks Institute.

The VIDEC System

Precise Control for Superior Black and White Photography

by Andrew C. Eads

A masterful system for film-based black and white photography that unifies how we see with the way film really works.

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