United States
Environmental Protection
Agency

Region 10
1200 Sixth Avenue
Seattle WA

July 1986

EPA

Fundamentals of Photography for Government

Fundamentals of Photography for Government

When you take a Government camera with Government film out on an assignment, you are making the effort to visually document key activities related to your work. Success in this task requires a commitment on your part to gain knowledge of and insight into photography. This publication is intended to help you in this effort.

The first step in the learning process is to understand the 3-cornered, 3-way relationship between ***light***, ***film***, and ***camera***. Competence begins with a grasp of the interplay between these elements.

Normally we take light for granted — our eyes adjust to light automatically. But when you use light as a tool for making photo-images, you must become sensitive to certain qualities of both the light and the subject illuminated.

CONSIDER:

- **The *relative brightness* of light and subject.**
- **The *kind of source*. Sun? Electrical light?**
- **The *direction* of the light**
- **The *relative brightness* of the surrounds.**

These elements are crucial to certain decisions you, as a photographer, will have to make. And successful picture taking is based on a foundation of correct decision making. The ***relative brightness*** and the ***kind of source*** directly influence your choice of film. And the ***direction of light*** and ***subject surrounds*** influence how you set your camera's controls. It is tremendously helpful if you have a prior knowledge of the conditions under which you will photograph. This knowledge is the basis of the selection of camera and lens, the basis of the selection of film, and the basis of the decision-making process that you, as a Government photographer, will be involved in.

Film

Film is your medium, your image-recording tool. All films use a very limited range of light to make an image. The limits imposed are determined by the rate at which light-sensitive silver halide crystals coated on the film respond to light.

Larger silver crystals are more light-sensitive and respond to light more quickly than smaller ones. Film coated with such crystals are said to be ***fast*** and are given a numerically higher rating. ***Slow*** films are coated with smaller crystals and respond to light less readily.

All film, no matter what its rated speed, responds to a much narrower range of light than the human eye. That very limited range of light brightness where a film will produce a ***useable*** image is what the photographer has to work with. Pictures made under conditions which exceed this limited range of light brightness striking the film will be difficult or impossible to use as records or evidence.

Overexposed
(A very bright, very light final picture)

Underexposed
(A very dark, very dim final picture)

Optimum Exposure
(Final picture exactly as the photographer desired)

Worthless Exposed Film
(In excess of either the limits of acceptable overexposure or underexposure - pictures in which the subject cannot be made visible)

The range of acceptable exposure on both sides of the ***optimum*** exposure is called the film's ***latitude***.

Films are classified by the rate at which light forms images on the film by the ***ASA/ISO*** film speed number system. The slower the film's response to light, the lower the number; the faster the film responds to light, the higher the number. For example, ASA/ISO 25 is about the slowest film commonly available, and ASA/ISO 1000 is the fastest.

Film Speeds: Advantages and Limitations

ASA/ISO 25-64	Good for fine detail, generous latitude, low contrast.	Limited to daylight hours. Less light, bad weather, may require flash or tripod.
ASA/ISO 64-200	Adequate detail and latitude, medium contrast, better for action or low light levels than slow films.	Slight loss of fine detail, limited extension of daylight photo activity, flash or a tripod may still be needed in low light.
ASA/ISO 400-1000	Good for action and low light levels, dark subjects and surrounds.	Loss of fine detail, narrow latitude, high contrast.

These generalized statements apply to both color and black and white films. See specific film commentary in the **Photograph for Evidence** section.

Camera

There is light and a subject which reflects light in varying degrees - light to dark. There is film, responding to a limited range of light intensity to form the image. And to weld the two, to match and balance, to catch the picture is the camera (and, of course, the operator).

This machine performs several important functions - some obvious and some not:

- It holds the film flat, centered to the lens, and at 90° to the lens axis.
- It provides a means for you to view and frame your photo before you take it.
- It moves fresh, unexposed film into the flat, centered, 90° position behind the lens for the next picture.
- It gives you the ability to take the picture exactly when you want to.

But most important of all -

The camera provides the controlling functions for adjusting the amount of light that will strike the film to make the image.

These controlling functions are ***shutter speed*** and ***f-stop***. They govern ***Time*** and ***Volume***.

Time is controlled by the ***shutter***, which is normally closed, admitting no light at all. When the shutter operates, a blink of light flashes on the film. You regulate the duration of this blink by controlling the shutter's mechanism. This blink is measured in fractions of a second, usually beginning with one second. The standard progression of the shutter's blinks for today's cameras is 1/2, 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, and 1/1000 of a second.

The relationship between these fractions of a second is an important concept. Moving the shutter speed control towards smaller (shorter) slices of time, each new shutter speed selected is **1/2** the value of the previous setting. Moving the shutter speed control towards larger (longer) amounts of time, each new shutter speed is **twice (2X)** the value of the previous setting. **Remember this halving and doubling relationship!**

The volume of light admitted to the film during shutter operation — when you take the picture — is a function of the lens opening, called ***aperture***. Apertures are standardized by ***'f' numbers*** (referred to as ***'f' stops***).

When selecting the ***f-stops***, it is crucial to understand that each subsequent (numerically higher) 'f' number will result in a reduction of the volume of light striking the film equal to ***half (1/2)*** the volume at the previous setting. Conversely, starting at the smallest ***aperture*** (usually f22), each numerically lower 'f' number selected will result in a ***doubling (2X)*** of the volume of light striking the film when the picture is taken. **Remember this halving and doubling relationship!**

Each single increment of change in either the lens aperture control or the shutter speed is called a ***stop***. You either increase or decrease exposure by one or more stops. When you wish to refer specifically to an increment of change in lens aperture, use the term ***'f-stop'***.

The halving-doubling relationship of the shutter speeds results in the same changes in exposure as the doubling-halving relationship of the lens aperture control. This 'equivalency' means that for any ***one*** given correct exposure, an array of shutter speed and aperture combinations will deliver that exposure!

1st Example: ASA/ISO 25 Film
in Bright Daylight
f8 at 1/125 sec.

Decreasing Volume/Increasing Time	Increasing Volume/Decreasing Time
f11 at 1/60 sec.	**f5.6 at 1/250sec.**
f16 at 1/30 sec.	**f4.0 at 1/500 sec.**
f22 at 1/15 sec.	**f2.8 at 1/1000 sec.**

(All these give the same exposure!)

2nd Example: ASA/ISO 400 Film
in Bright Daylight
f16 at 1/500 sec.

Decreasing Volume/Increasing Time	Increasing Volume/Decreasing Time
f22 at 1/250 sec.	**f11 at 1/1000sec.**

(All these give the same exposure!)
Notice how limited fast film is when used in unsuitable conditions.

3rd Example: ASA/ISO 400 Film
Nighttime Indoors — By Room light
f2.8 at 1/60 sec.

Decreasing Volume/Increasing Time	Increasing Volume/Decreasing Time
f1.4 at 1/250 sec.	**f22 at 1 sec.**
f2.0 at 1/125 sec.	**f16 at ½ sec.**
f4 at 1/30 sec.	**f11 at ¼ sec.**
f5.6 at 1/15sec.	**f8 at 1/8 sec.**

(All these give the same exposure!)

The equivalency relationship of lens apertures and shutter speeds ties into the ASA/ISO film speed scale as follows: Each doubling of the ASA/ISO film speed will result in a one stop reduction of exposure for any given subject-lighting situation. (= ½ the previous exposure). Any reduction by half of the ASA/ISO number will result in a one stop increase of exposure for any given subject-lighting situation.

Examples:

ASA/ISO 25	Bright	f8 at 1/125	changes by
ASA/ISO 64	Daylight	f8 at 1/250	1 stop
ASA/ISO 25	Bright	f8 at 1/125	changes by
ASA/ISO 200	Daylight	f8 at 1/1000	3 stops
ASA/ISO 25	Sunset	f5.6 at 1/8	changes by
ASA/ISO 400		f5.6 at 1/125	4 stops

All of this exposure change through different film speed must be considered when selecting film.

To sum up, as you reduce the volume of light transmitted by the lens to the film, you must increase the length of time this light strikes the film in order to keep an equivalent total exposure. Likewise, as you decrease the time of exposure, you must increase the volume of light by an equivalent amount to maintain the same exposure.

What this span of alternate exposure settings means is that the light-camera-film interplay may be adjusted to suit the desires of the photographer and the needs of the situation. For example, if you are photographing action, ***and*** wish to stop or *"freeze"* the motion, reset the exposure towards smaller (shorter) amounts of time (shutter speed) and larger volumes of light (f-stop). By maintaining this equivalency, the exposure will remain the same. If you are shooting landscapes, and want the great depth of field that comes with small lens openings, ***and*** there is little or no motion of subject, use a tripod or some other steady rest and stop the lens down as far as you wish. With the reduction in the volume of light, the time must increase. When equivalency to the base exposure is reached, take the picture.

The simple single focal length lens of 50-55 mm size is standard with most new camera purchases. After that, the choice of lenses facing the photographer is staggering. Almost all of these lenses share some common features, such as:

- **Focusing mechanism.**
- **Adjustable aperture and control ring.**
- **Lens to camera mount.**
- **Depth of field and distance scales.**
- **Mechanism for coupling to camera body for various automatic functions.**

Of these features, depth of field will pose the most problems for the beginning photographer. Some general statements about depth of field that will help are:

- **Depth of field is the zone of acceptable sharpness of image in the lens field of view.**

- **Depth of field varies as a function of two other variables:**
  1. **Focus distance.**
  2. **Lens aperture selected.**

- **Depth of field increases as focus distance increases.**

- **Depth of field increases as the diameter of the aperture decreases.**

- **Depth of field relationship to focus distance and aperture selected is shown for any lens by the depth of field scale on the lens barrel.**

At Last! The Photographer

When you decide to take some pictures, think about when you are going to take them - consider the time of day and the weather. Perhaps more important, look at and think about ***what*** is going to be your subject and surrounds. With all this in mind, select your film.

If your camera is an EPA or a recent generation automated camera, you will benefit from a recent innovation in camera design — automatic exposure control.

All of the foregoing information about apertures and shutter speeds and film has led you to this point. Now you are going to discover that, thanks to your modern camera, none of this information is going to have much direct bearing or relevancy on your actions prior to pushing the shutter button. The camera does it all!

Well. . . *almost*. You still have some actions to take, some decisions to make, choices to consider — Let's go through them.

- **You've picked the film you're going to use. Now, check that your camera is equipped with functioning batteries. Always carry a spare set.**

- **Check and double check that the correct film speed (ASA/ISO) number is indicated on the camera's film speed dial. A mistake here could waste the entire roll of film.**

- **Consider lens focal length and decide if you should use a different lens than the standard item already on the camera.**

- **And finally, with most of today's cameras, you have to choose what mode of camera automation the picture will be taken in! This is a subject you can learn more about in your camera's instruction book or manual. But keep in mind that *some* form of manual control is almost always provided for in modern, automated cameras.**

But despite all the automation available to the photographer today, a full understanding of the fundamentals outlined in these pages will help you to take better pictures.

For specifics on film selection and photographic techniques, read the following chapter **Photography for Evidence**.

Photography for Evidence

Now is a time at EPA when the enforcement of environmental laws depends to an ever greater degree on the activities of the data gatherers. And increasingly, photography plays an important role in that process. The investment of time and material in photography for data and evidence can only be justified by the quality and usefulness of the results. What follows is a collection of facts and insights aimed at helping you optimize the results of your photographic efforts.

Equipment and Techniques

- **Where precision in aiming and focusing the camera is essential...**
- **Where exposure determinations are difficult...**
- **Where picture taking at a distance or up very close may be part of the same assignment...**
- **Where action sequence pictures may be vital to documentation...**

Then selection of a single lens reflex camera with appropriate accessory equipment becomes necessary. This type of camera, with it's ability to measure exposure through the picture-taking lens, and it's adaptability to a wide range of lenses, motor drives, and special purpose accessories, is the most useful instrument the Government photographer can employ.

However, there are tradeoffs. Single lens cameras and accessories are bulky, heavy, noisy, and not very suitable for subtle picture taking.

- **Where speed of operation is important...**
- **Where silent operation is desirable...**
- **When the camera must be concealed...**

Then select one of the small fixed-lens, simple-focusing cameras. Compact, light-weight, with automatic exposure and a wide angle lens as standard, these instruments are excellent for 'grab' shots...picture taking on the move. The tradeoffs are a lack of flexibility and an absence of precision in aiming and focusing. *(Not really necessary in this type of camera).*

Most of today's 35mm cameras have provision for automatic exposure adjustment. But, the photographer must:

- **Check for working batteries in the camera, and the availability of fresh spare batteries.**
- **Ensure that the camera's ASA/ISO film speed setting *is correct* for the film being used.**

Camera automated exposure systems work well, but ***there are exceptions***:

- **Where the light source is strong and direct — (bright sun, single light bulb, one window), *beware of high contrast*! Where the subject/scene incorporates both very bright and very dark areas, *beware of high contrast*!**

Where high contrast exists, with brights and darks in the picture, and little in the way of medium tone values, the photographer must:

- **Make a judgment call as to which part of the viewed image is most important.**
- **Override the camera's exposure automation correctly for the desired result.**

Since most camera metering systems read light intensities and ***average*** them, high contrast picture situations will fool the exposure automation. You have to identify the problem, make the judgment call, and adjust your camera to compensate for the problem.

Example

Judgment Call #1

Detail in the brightest area is the most important. Adjust camera override towards underexposure (1/2X, 1/4X, or -1 or -2).

Judgment Call #2

Detail in the darkest area is most important. Adjust camera override towards overexposure (2X, 4X, or +1 or +2).

Return override to neutral when need for compensation is over!

Since an accurate exposure determination may be difficult, and since film is comparatively cheap — ***bracket your exposures!*** Take two, three, or even four pictures of the same shot at different settings, using your judgment call as a guide.

Exposure compensation may also be accomplished by doubling the ASA/ISO number for each stop of underexposure desired. Resetting to half the previous ASA/ISO number will provide one stop of overexposure. Remember to reset to the proper ASA/ISO number for your film when the need for exposure compensation is past.

You may expect to encounter high contrast situations on any bright, cloudless, sunny day, and at any time dark objects are positioned against a light background, or the reverse. ***Beware of including too much sky in your pictures***, and be aware of reflected light when photographing over or around water. Strong directional sidelight will produce harsh shadows, and any interior pictures that include light bulbs (lit) or windows will cause problems. Just remember: ***Make your judgment call, alter the exposure compensation correctly, and then, to make sure, bracket the exposure***.

Using a single lens reflex camera means you are going to confront the complexities of lens interchangeability and the many choices of lenses which fit and work on your camera.

Because its perspective most closely matches that of the human eye, the lenses in the 50-55 millimeter focal length are termed ***normal focal length***. Lenses with focal lengths of lower numerical value are called ***wide angle***, while lenses with higher numbered focal lengths are called ***telephoto***.

Zoom lenses offer a continuous range of focal lengths in one lens. Some zoom lenses run from wide angle to normal, some from normal focal length to telephoto, and some zoom lenses offer a full range from wide angle to telephoto.

For evidential photography, lenses are used in the following ways. ***Normal*** and ***wide-angle lenses*** are suitable for site and area overviews. But remember that the ***wide angle lens distorts perspective and distance***. Also, because a wide angle lens takes in a wider field of view, the apparent size of everything in the picture will be reduced.

Use a ***macro lens*** for label and close-up photography. A less satisfactory solution is the zoom lens with macro capability. Because of depth of field limitations, ***use a tripod*** and ***stop the lens down*** for best results (f22 or f32 preferred). When you cannot use a tripod, use the smallest aperture consistent with a shutter speed of not less than 1/60 second, and avoid focusing too closely.

Telephoto lenses offer magnification of image size with a somewhat unrealistic perspective.

135mm = 2+ powers of magnification for a 35mm camera.
200mm = 4 powers of magnification for a 35mm camera.
400mm = 8 powers of magnification for a 35mm camera.
500mm = 10 powers of magnification for a 35mm camera.

Every increase in magnification increases the potential for loss of sharpness due to camera motion. A good rule of thumb for handholding a camera-telephoto lens combination is to ***never use a shutter speed less than the focal length of the lens***.

Use a tripod wherever and whenever possible. The selection of faster films for photography with telephoto lenses is also beneficial.

When photographing in the field with a tripod, try to avoid setting up near roads and highways that are used by heavy traffic. Ground vibration can destroy image sharpness.

Filtration for evidentiary photography with color film may be beneficial. Here is a list of the most useful filters and their applications.

UV-1 Cuts excess blue color cast above 4000ft. altitude.
Skylight Cuts excess blue color cast, has a very slight warming effect.
81A Warming filter;good for open shade photography, and for use on days of heavy overcast.
80A & 80B Color conversion filters for daylight films used under tungsten light, 2-3 stop filter factor.
85A Color conversion filter for tungsten films used with daylight, 1 1/2-2 stop filter factor.
Polarizer Most useful. For photo taking through glass, it minimizes surface reflections off glass and water. Also causes increased saturation of colors and performs interesting magic with contrast. Must be used with the sun either to your left or right side - any other orientation diminishes filter effectiveness. 1 to 3 stop filter factor. ***Note:*** *some polarizers are variable density.*

Film Selection

To obtain the best possible results in the pictures that you take, select your film carefully. Know the conditions you will be shooting pictures under and let this be your guide to film selection.

- **Where light levels are low...**
- **Where subjects are in motion...**
- **Where subjects are dark in tone or color...**
- **Where telephoto lenses must be used...**

Then select the fastest film you feel will capture the needed image. There are tradeoffs: the faster the film, the poorer it's ability to resolve fine detail, and the less margin for exposure error.

The slowest film having useful speed for these kinds of situations is Ektachrome 200.

Here are some other fast film choices for you to consider:

Tri-X *black and white film rated at ASA/ISO 400; can be used up to ASA/ISO 1600 with special development.*

Ektachrome 400 *color film rated at ASA/ISO 400; can be used up to ASA/ISO 1000 with special development. Notify Kodak if special development is required by using their ESP-1 processing envelope.*

Ektachrome 800-1600 *color film with variable ASA/ISO. Kodak must be informed as to ASA/ISO actually used.*

Kodacolor 400 *color film. Expensive.*

Kodacolor 1000 *color film. Also expensive.*

NOTE: *When a film is identified by use of the word 'chrome' in it's name, that film is a color transparency or slide film. When the film's name includes the word 'color,' the product is a print film. Ektachrome films have the advantage, along with kodacolor films, of being suitable for local processing within short time spans. Both print films have the ability to be used under available light from different sources without corrective filtration.*

- **Where light is of sufficient brightness...**
- **Where subjects motion is slower paced...**
- **Where subjects are average or above average in brightness...**
- **Where detail rendition must be excellent...**

Then select one of the slower films, such as:

Kodachrome 25 *color film. It is the slowest speed color film Kodak offers, and has the highest resolution of all Kodak color films.*

Kodachrome 64 *color film. A bit more than one stop faster than ASA/ISO 25 film, this product is almost as good.*

Ektachrome 64 *color film. Closely duplicates Kodachrome 64. Offers rapid processing turnaround time.*

Kodacolor 100 *color film. Has the highest resolution of all Kodak color print films. Expensive. Shares same lighting flexibility as its faster relatives.*

Panatomic X *black and white film. ASA/ISO 32. Has the highest resolution of the conventional Kodak b&w films.*

Tech Pan 2415 *black and white film. ASA/ISO 25. A special film, requiring special development. Essentially grain free.*

Any of these slower films will work well in daylight out-of-doors situations. Where lower light levels are involved, or when the use of telephoto lenses is desired or necessary, a tripod or good steady rest would be essential.