NONRESIDENT TRAINING COURSE

October 1993

Photography (Basic)

NAVEDTRA 14209

NOTICE

Pages 1-1, 1-3, 3-6, 12-2, and 12-3 must be printed on a **COLOR** printer.

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

Although the words "he," "him," and "his" are used sparingly in this course to enhance communication, they are not intended to be gender driven or to affront or discriminate against anyone.

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Errata #1 25 MAY 99

Specific Instruction and Errata for
Nonresident Training Course

PHOTOGRAPHY (BASIC)

1. No attempt has been made to issue corrections for errors in typing, punctuation, etc. that do not affect your ability to answer the question or questions.

2. To receive credit for deleted questions, show this errata to your local course administrator (ESO/scorer). The local course administrator isdirected to correct the course and the answer key by indicating the questions deleted.

3. Change the following items in the NRTC:

a. Question 1-56: change Alt 3 from "545.45 feet" to "45.46 feet"

b. Question 2-75: change Alt 2 from "120°F" to "122°F"

c. Question 3-52: change the word "camera" in the question's stem to "light meter"

d. Page 36, Figure 5A: change Alt E from "How" to "Who"

e. Question 6-15: change the first word in line 2 of the question's stem from "control" to "limit"

f. Question 7-10: change the date in line 5 of the question's stem from "1885" to "1985"

g. Question 9-1: change Alt 3 from "No. 0" to "No. 3"

h. Question 9-70: change Alt 3 from "CCO5Y + CC15M only" to "CC05Y + CC10M only"

i. Question 10-49: change Alt 3 from "Censorship and physical" to "Censorship and physical security"

j. Question 10-49: change Alt 4 from "Physical and cryptographic" to "Physical security and cryptographic."

4. Delete the following questions and leave the corresponding spaces blank on the answer sheets:

Questions: 3-21, 3-27, 3-28, 6-54, 10-45

PREFACE

By enrolling in this self-study course, you have demonstrated a desire to improve yourself and the Navy. Remember, however, this self-study course is only one part of the total Navy training program. Practical experience, schools, selected reading, and your desire to succeed are also necessary to successfully round out a fully meaningful training program.

COURSE OVERVIEW: In completing this nonresident training course, you will demonstrate a knowledge of the subject matter by correctly answering questions on the following topics: Theory of Light and Optical Principles; Light Sensitive Cameras and Controls; Basic Photographic Techniques; Photographic Assignments; Portraiture; Copying; Chemical Mixing; Image Processing and Control; Black-and-White Printing; Color Printing; Motion Media; and Job Control and Photographic Finishing.

THE COURSE: This self-study course is organized into subject matter areas, each containing learning objectives to help you determine what you should learn along with text and illustrations to help you understand the information. The subject matter reflects day-to-day requirements and experiences of personnel in the rating or skill area. It also reflects guidance provided by Enlisted Community Managers (ECMs) and other senior personnel, technical references, instructions, etc., and either the occupational or naval standards, which are listed in the *Manual of Navy Enlisted Manpower Personnel Classifications and Occupational Standards*, NAVPERS 18068.

THE QUESTIONS: The questions that appear in this course are designed to help you understand the material in the text.

VALUE: In completing this course, you will improve your military and professional knowledge. Importantly, it can also help you study for the Navy-wide advancement in rate examination. If you are studying and discover a reference in the text to another publication for further information, look it up.

1993 Edition Prepared by
PHC(AW) Dale Freelan

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AND TECHNOLOGY CENTER

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Sailor's Creed

"I am a United States Sailor.

I will support and defend the Constitution of the United States of America and I will obey the orders of those appointed over me.

I represent the fighting spirit of the Navy and those who have gone before me to defend freedom and democracy around the world.

I proudly serve my country's Navy combat team with honor, courage and commitment.

I am committed to excellence and the fair treatment of all."

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SUMMARY OF PHOTOGRAPHER'S MATE TRAINING MANUALS

PHOTOGRAPHY (BASIC)

Photography (Basic), NAVEDTRA 12700 consists of the following subjects: the principles associated with light, optics, cameras, light-sensitive materials, and equipment; still and motion-media shooting techniques; chemical mixing; image processing and printing; job control; and photographic finishing.

PHOTOGRAPHY (ADVANCED)

Photography (Advanced), NAVEDTRA 12701 consists of the following subjects: aerial photography; photographic quality assurance; electronic imaging; photographic layout and design; photographic supply; and silver recovery.

CREDITS

The illustrations listed below are included in this edition of *Basic Photography*, through the courtesy of the designated sources. Permission to use these illustrations is gratefully acknowledged. Permission to reproduce illustrations and other materials in this publication must be obtained from the source.

SOURCE	FIGURES
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EG&G, Inc., Electro-Optics Division	10-24
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Ilford Photo	11-7
Kreonite, Incorporated	9-4, 12-6
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INSTRUCTIONS FOR TAKING THE COURSE

ASSIGNMENTS

The text pages that you are to study are listed at the beginning of each assignment. Study these pages carefully before attempting to answer the questions. Pay close attention to tables and illustrations and read the learning objectives. The learning objectives state what you should be able to do after studying the material. Answering the questions correctly helps you accomplish the objectives.

SELECTING YOUR ANSWERS

Read each question carefully, then select the BEST answer. You may refer freely to the text. The answers must be the result of your own work and decisions. You are prohibited from referring to or copying the answers of others and from giving answers to anyone else taking the course.

SUBMITTING YOUR ASSIGNMENTS

To have your assignments graded, you must be enrolled in the course with the Nonresident Training Course Administration Branch at the Naval Education and Training Professional Development and Technology Center (NETPDTC). Following enrollment, there are two ways of having your assignments graded: (1) use the Internet to submit your assignments as you complete them, or (2) send all the assignments at one time by mail to NETPDTC.

Grading on the Internet: Advantages to Internet grading are:

- you may submit your answers as soon as you complete an assignment, and
- you get your results faster; usually by the next working day (approximately 24 hours).

In addition to receiving grade results for each assignment, you will receive course completion confirmation once you have completed all the assignments. To submit your assignment answers via the Internet, go to:

http://courses.cnet.navy.mil

Grading by Mail: When you submit answer sheets by mail, send all of your assignments at one time. Do NOT submit individual answer sheets for grading. Mail all of your assignments in an envelope, which you either provide yourself or obtain from your nearest Educational Services Officer (ESO). Submit answer sheets to:

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Answer Sheets: All courses include one "scannable" answer sheet for each assignment. These answer sheets are preprinted with your SSN, name, assignment number, and course number. Explanations for completing the answer sheets are on the answer sheet.

Do not use answer sheet reproductions: Use only the original answer sheets that we provide—reproductions will not work with our scanning equipment and cannot be processed.

Follow the instructions for marking your answers on the answer sheet. Be sure that blocks 1, 2, and 3 are filled in correctly. This information is necessary for your course to be properly processed and for you to receive credit for your work.

COMPLETION TIME

Courses must be completed within 12 months from the date of enrollment. This includes time required to resubmit failed assignments.

PASS/FAIL ASSIGNMENT PROCEDURES

If your overall course score is 3.2 or higher, you will pass the course and will not be required to resubmit assignments. Once your assignments have been graded you will receive course completion confirmation.

If you receive less than a 3.2 on any assignment and your overall course score is below 3.2, you will be given the opportunity to resubmit failed assignments. **You may resubmit failed assignments only once.** Internet students will receive notification when they have failed an assignment--they may then resubmit failed assignments on the web site. Internet students may view and print results for failed assignments from the web site. Students who submit by mail will receive a failing result letter and a new answer sheet for resubmission of each failed assignment.

COMPLETION CONFIRMATION

After successfully completing this course, you will receive a letter of completion.

ERRATA

Errata are used to correct minor errors or delete obsolete information in a course. Errata may also be used to provide instructions to the student. If a course has an errata, it will be included as the first page(s) after the front cover. Errata for all courses can be accessed and viewed/downloaded at:

http://www.advancement.cnet.navy.mil

STUDENT FEEDBACK QUESTIONS

We value your suggestions, questions, and criticisms on our courses. If you would like to communicate with us regarding this course, we encourage you, if possible, to use e-mail. If you write or fax, please use a copy of the Student Comment form that follows this page.

For subject matter questions:

E-mail: n313.products@cnet.navy.mil
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NAVAL RESERVE RETIREMENT CREDIT

If you are a member of the Naval Reserve, you may earn retirement points for successfully completing this course, if authorized under current directives governing retirement of Naval Reserve personnel. For Naval Reserve retirement, this course is evaluated at 15 points. These points will be credited to you upon satisfactory completion of the assignments as follows:

UNIT	ASSIGNMENTS	POINTS
1	1-8	12
2	9-10	3

(Refer to *Administrative Procedures for Naval Reservists on Inactive Duty,* BUPERSINST 1001.39, for more information about retirement points.)

Student Comments

Course Title: *Photography (Basic)*

NAVEDTRA: 14209 **Date**: _____

We need some information about you:

Rate/Rank and Name: _____ SSN: _____ Command/Unit _____

Street Address: _____ City: _____ State/FPO: _____ Zip _____

Your comments, suggestions, etc.:

Privacy Act Statement: Under authority of Title 5, USC 301, information regarding your military status is requested in processing your comments and in preparing a reply. This information will not be divulged without written authorization to anyone other than those within DOD for official use in determining performance.

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CHAPTER 1

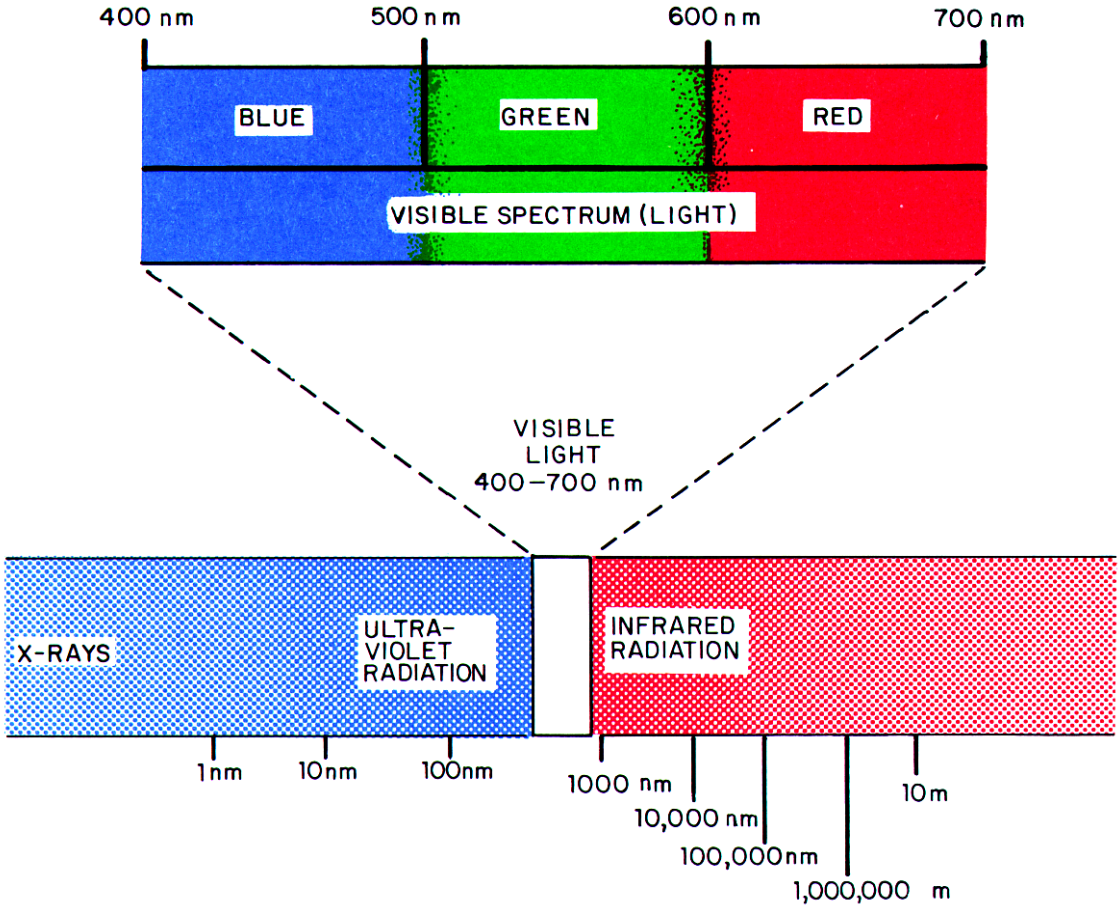
THEORY OF LIGHT AND OPTICAL PRINCIPLES

Light is the photographer's medium, and a photograph is the image of a pattern of light recorded on film. The word *photography* means *writing or drawing with light.* Without light there could be no vision or photography because it is light reflected from the world around us that makes things visible to both our eyes and the eye of the camera. The nature of light has a critical effect on the pictures you make. Few photographers actually understand much about light. But they are not alone. Scientists have never been able to agree fully about the nature of light. However, certain useful things are clear and well understood about how light behaves.

Light is a form of electromagnetic radiant energy to which the eye is sensitive. It travels at tremendous speed from its source, such as the sun, a fluorescent lamp, an electronic flash, or whatever source is used. It has an effect on the materials it falls on, skin becomes tanned, and fruit is ripened by the light of the sun. Depending on the way in which light is received or rejected, a complex pattern of light, shade, and color results.

Other types of radiant energy, such as radio waves and X rays, are similar to light but the eye cannot see them. Thus they are not light. By definition, light is electromagnetic energy visible to the human eye. All other electromagnetic energy is invisible, therefore, is not considered light. Ultraviolet and infrared radiations are two such invisible radiations that are of concern to the photograper.

Light makes up the visible spectrum, which is a small part of the entire electromagnetic spectrum (fig. 1-1).



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Figure 1-1.–The electromagnetic energy spectrum.

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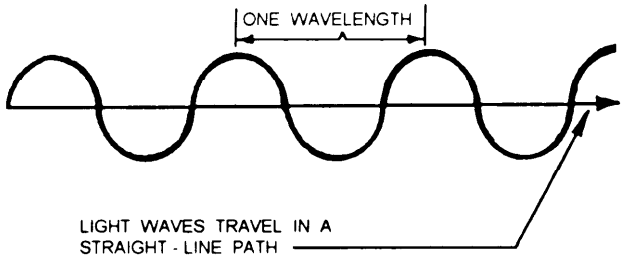


Figure 1-2.–Wavelength.

CHARACTERISTICS OF LIGHT

The subject of light as a form of radiant energy has been theorized upon, experimented with, and studied by many physicists and scientists. Until about three centuries ago, no one had developed a reasonable theory of the nature of light. Then Max Planck, a physicist, published a theory in which light was supposed to consist of a stream of high-speed particles. Planck theorized that any light source sent out an untold number of these particles. This then was the *quantum theory*. *The quantum* of light is called the *photon.* The quantum theory is used to explain X ray, radiation, and photoelectricity.

WAVELENGTH, SPEED, AND FREQUENCY

About the same time other physicists, Christiann Huygens and Thomas Young, introduced a theory called the *wave motion theory.* The wave motion theory is used to explain reflection, refraction, diffraction, and polarization. In wave motion theory, light, wavelength, speed, and frequency are important characteristics, and they are interrelated.

The wavelengths of light are so small that they are measured in nanometers (nm). A nanometer is equal to one millionth of a millimeter. Wavelengths of light range from about 400nm to 700nm in length and travel in a straight-line path.

The speed of light varies in different mediums. In air, light travels about 186,000 miles per second. In a denser medium, such as glass, light travels even more slowly. Furthermore, in a denser medium, the speed is different for each color of light. Wavelength is the distance from the crest of one wave to the crest of the next wave (fig. 1-2). Frequency is the number of waves passing a given point in 1 second. The product of the two is the speed of light.

Therefore:

$$Speed = Wavelength \times frequency, \text{ or}$$

$$Wavelength = \frac{Speed}{Frequency}$$

Since the speed of light in glass is slower than in air, the wavelength must also be shorter (fig. 1-3). Only the wavelength changes; the frequency remains constant. Hence we identify a particular type of radiation (color of light) by its wavelength, *bearing in mind that we are speaking of the wavelength in air.*

EMISSION OF LIGHT

To the photographer, there are two important characteristics of the way light travels. First, in a given medium, light always travels in a straight line. Second, in a given medium, it travels at a constant speed.

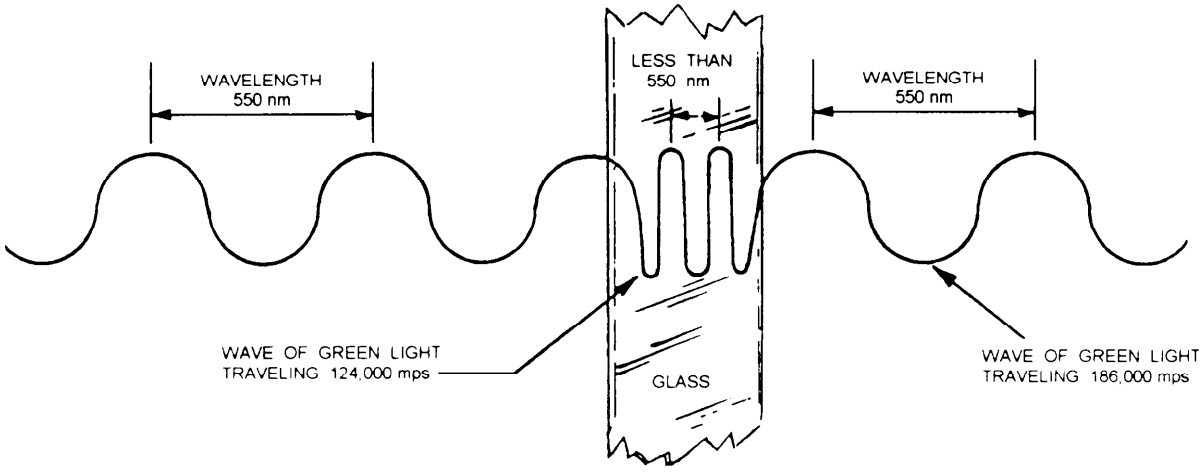


Figure 1-3.–Variation in speed and wavelength.

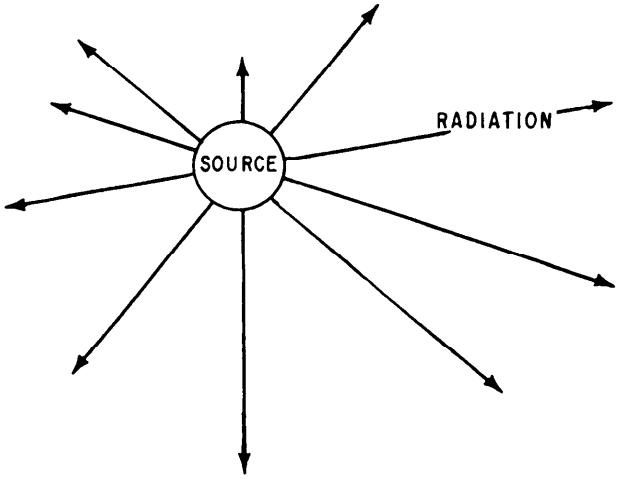


Figure 1-4.–Light emitted from a source.

Once light is produced (emitted), it is no longer dependent on its source, and only its speed is affected by the many mediums through which it can travel. Another example of the independence of light is that when light travels from air into a denser but transparent medium, such as glass, its speed is reduced. But when it leaves the glass, it returns to its original speed. This changing speed is important in *refraction*, a behavior of light that allows lenses to form images.

Unless light is reflected or focused, it travels or radiates in all directions from the source. As light travels from the source, its energy of light spreads out. The greater the distance it travels, the more it spreads out (fig. 1-4). Therefore, the amount of light reaching a given area at a given distance is less than that reaching the same area closer to the source. In other words, the intensity of illumination on a surface varies when the distance between the light source and the surface, or subject, is changed. This becomes important when exposing film with artificial light.

COLOR OF LIGHT

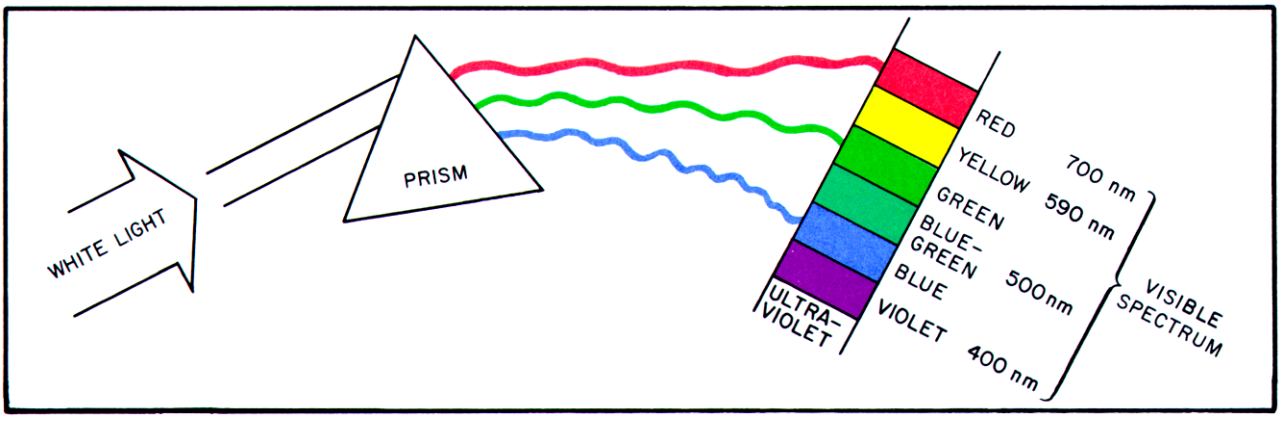
Look at a bright, red apple on a dark, green tree. It is hard to believe that color is not an inherent property of these objects; in fact color is not even inherent to light. What you are seeing is a visual perception stimulated by light. The apple and tree are only visible because they reflect light from the sun, and the apple appears red and the tree appears green because they reflect certain wavelengths of light more than others. In this case, these particular wavelengths are seen by the human eye as red and green. When we see a color, we are simply seeing light of a particular wavelength.

When a beam of light has a relatively even mixture of light of all visible wavelengths, it appears as white light. When this beam of white light is passed through a prism, its different wavelengths are spread apart and form a visible spectrum. This visible spectrum is seen as a band of colors, such as violet, blue, blue-green, green, yellow, and red (fig. 1-5).

COLOR TEMPERATURE

White light is made up of nearly equal intensities of all wavelengths within the visible spectrum. By passing white light through a prism, scientists have found that light sources have many qualities. They are as follows:

- Different wavelengths are present in the sources of radiant energy.
- The frequency and color of wavelengths vary.



C302.8

Figure 1-5.–Refraction of light by a prism.

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- With each wavelength, there is a variation in the amount of energy.

This variation of energy is called spectral energy distribution. The spectral energy of a light source is represented by color temperature. These terms are used in photography to describe and define the sources of light being used.

Color temperature describes the color quality of a light source in terms of the amounts of red light and blue light. Color temperature is based on what is called a *Planckian radiator,* or simply a *black body.* As the temperature of *the* metal of *the black body* is raised, it goes from a dull black through red and orange to blue and finally to white heat. The quality of the light emitted is a function of the temperature of the metal. When the object is red-hot, the *color* temperature is low since red is at the low end of the scale; and when it is blue-white, the color temperature is high. However, the *temperature* at which a light source is burned does not control *color temperature;* for example, a fluorescent tube burns at a low 125°F, yet it has a high color temperature. Color temperature then is raised or lowered relatively by the amount of visible white light radiated from the source. Be careful not to get confused. Traditionally reddish light is known as *warm* and bluish light as *cold;* in actuality, the color temperatures is the other way around.

The most convenient way to describe the color temperature of a light source is by its Kelvin temperature. From a practical point of view, this term refers to the degree of whiteness of the light. Color temperature is measured on the Kelvin scale and is stated as Kelvin temperature. On the temperature scale, 0 K is the same as -273°C. Therefore, degrees Kelvin (K) are always 273 degrees higher than the same temperature on the Celsius scale. Thus a red-hot piece of iron with an approximate temperature of 2000°C has a color temperature of 2273 K. As the Celsius temperature of an object is raised, it emits a whiter light and produces a relatively higher color (Kelvin) temperature.

COLOR RELATIONSHIPS

Many ways have been devised to classify the colors we see. Though terminology may differ, it is generally agreed that color can be defined by three qualities: *hue, brightness,* and *saturation.*

- Hue-Hue is the actual color or wavelength reflected by an object-red, yellow, green, and so forth. For example, it could be said that the color of an object is blue. Blue identifies the hue. There are seven hues in the visible spectrum. These seven hues are as follows: blue, green, red, cyan, magenta, yellow, and white. Hue, however, is an inadequate description of a cola. To be more specific, we should say that an object is dark blue or light blue. Now we have described the brightness of the color.

- Brightness-The brightness of a color is independent of the hue. Two colors may have the same hue but different brightness. Thus, to describe a color or brightness, we say that it is dull, bright, vivid, or brilliant.

- Saturation-The saturation of a color is the degree to which the color departs from neutral gray of the same brightness. You can think of it as mixing black, gray, or white paint with a colored paint, thus diluting the color. In other words, saturation is a measure of color purity.

BEHAVIOR OF LIGHT

Light waves travel in straight lines. When light waves encounter an object or new medium, they act in one or more of the following ways:

- They may be reflected.
- They may be absorbed.
- They may be transmitted.

REFLECTION

When light is reflected, it acts in a certain way. When the reflecting surface is smooth and polished, the reflection is orderly, or *specular.* Specular light is reflected at the same angle to the surface as the light incident to the surface; that is, the path of the light reflected from the surface forms an angle exactly equal to the one formed by its path in reaching the surface. Thus *the angle of reflection is equal to the angle of incidence,* which is a characteristic of specular light (fig. 1-6, view A). However, when the object surface is not smooth and polished but irregular, light is reflected irregularly or *diffused* (fig. 1-6, view B); that is, the light is reflected in more than one direction.

Practically all surfaces reflect both specular and diffused light; smooth surfaces reflect more specular light, and rough surfaces more diffused light. Since diffused light is more common than specular light, it is of greatest value in photography. Objects that are not light sources are visible and therefore photographic.

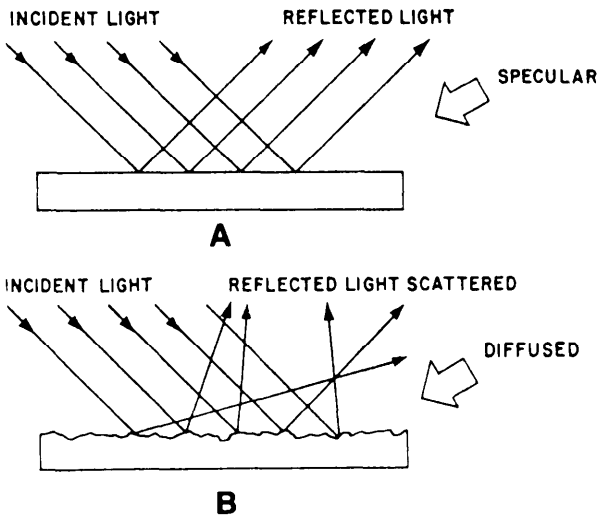


Figure 1-6.–Reflected light.

only because they reflect the light that reaches them from some luminous source.

ABSORPTION

When light strikes a medium and is neither reflected nor transmitted (passed on), it is said to be absorbed. Black cloth or areas of dark forest, for instance, absorb more light than objects such as a white sheet or a coral sand beach. When light comes in contact with the surface of an object, a certain degree of reflection, and some absorption, always takes place.

A medium that does not allow light to pass through it is *opaque.* An opaque material may also reflect light. When an object is opaque and the light is not reflected, it is absorbed by the object. When light is absorbed, its energy is converted and it no longer exists as light.

The color of an object is determined by the way it absorbs light falling upon it (incident light). A woman's dress appears red when it absorbs the blue and green rays of white light and reflects the red waves. A lawn appears green because the grass blades absorb the red and blue rays of light and reflect the green rays.

Neutral colors, such as white, black, and the various tones or values of gray, actually absorb almost equal proportions of the colors of light. Varying reflective powers account for their differences. White is highly reflective, while an object of absolute blackness, no matter how much light falls on it, can never be recorded on film except by contrast.

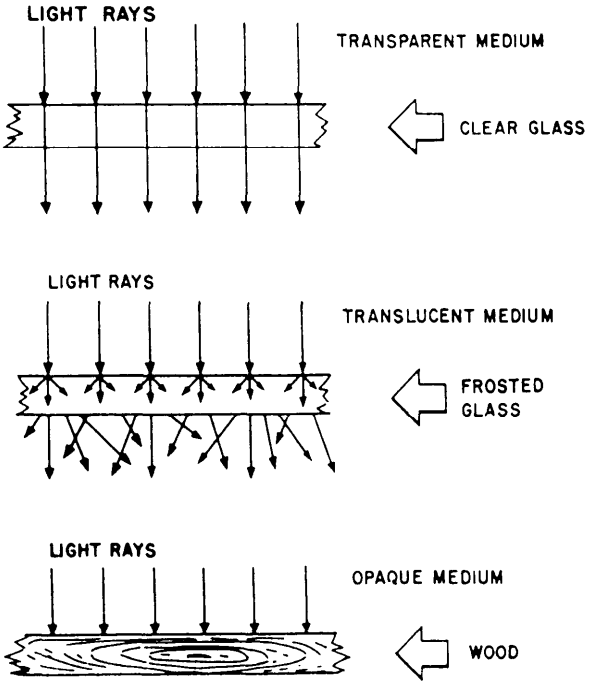


Figure 1-7.–Effects of different media.

TRANSMISSION

In addition to being reflected and absorbed, light rays may be transmitted. They may also pass through some medium they encounter. When objects can be clearly seen through the medium, the medium is *transparent.* A transparent medium transmits light rays in a regular, or uniform, pattern. When the medium transmits light but breaks up the orderliness of the pattern, sending the transmitted rays in many directions, the medium is *translucent.* In other words, a medium is said to be translucent when light is visible through it, but objects are NOT clearly distinguishable. Thin fabrics and frosted glass are examples of translucent materials that allow the passage of diffused light (fig. 1-7). One important form of transmission is termed *refraction.*

REFRACTION

The change of direction that occurs when a ray of light passes from one transparent substance into another substance of different density is called *refraction.* Refraction enables a lens to form an image. Without refraction, light waves behave as X rays and pass in straight lines through all suitable substances without any control of direction, and only shadow patterns can be made with them. Refraction occurs because light travels at different speeds in different transparent substances. The speed of light in each transparent substance is called

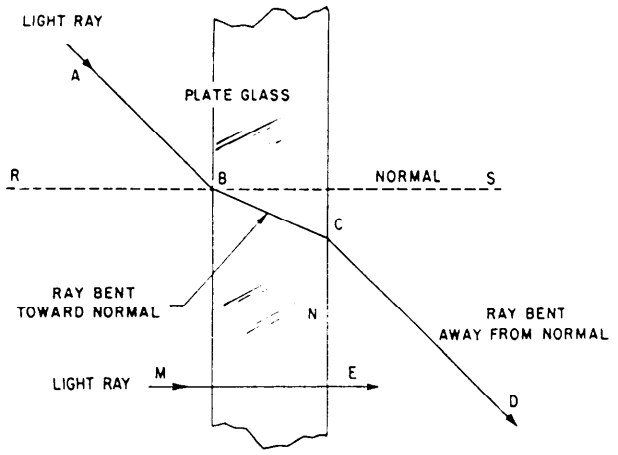


Figure 1-8.–The law of refraction.

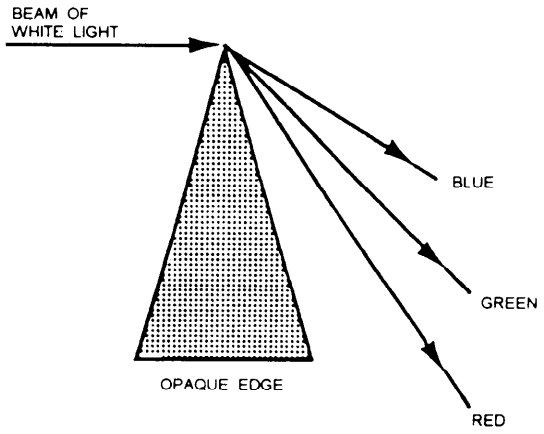


Figure 1-9.–Diffraction.

the index of refraction for that substance; for example, light travels about 1 1/2 times as fast in air as it does in glass, so the index of refraction for glass is about 1.5.

Refraction, or change of direction, always follows a simple rule.

- "In passing from one transparent substance into another of greater density, refraction is toward the normal. In passing from one transparent substance into another of lesser density, refraction is away from the normal." In this rule the normal is defined as a line perpendicular (90°) to the surface between the mediums.

Refraction is shown in figure 1-8. The ray of light (AB) strikes the glass at an oblique angle. Since the glass is denser than air, the ray of light is bent toward the normal (RS) and emerges from the glass at (C). Upon entering the air again, the ray is bent away from normal (RS) and travels along the path (CD).

All rays striking the glass at an angle other than perpendicular are refracted. In the case of the perpendicular ray (ME) that enters the glass normal to the surface, no refraction takes place and the ray continues through the glass and into the air in a straight line.

DISPERSION

The speed of light in a medium depends on the wavelength of the light. As light enters a more dense medium, the short waves, such as blue, are slowed more than the long waves, such as red. Thus the index of refraction of a medium varies with the wavelength, and the different colors of light are bent different amounts. This changing index of refraction or the breaking up of white light into its component colors is called *dispersion.* This then ties in with the previous discussion of the colors of light where we saw the way a prism creates a spectrum from white light. The prism is able to create this spectrum because of dispersion.

DIFFRACTION

We have said that light travels in a straight line. Well, that is not always true. An exception to this rule occurs when light travels close to an opaque edge. Because of the wave nature of their travel, light rays passing near an opaque edge are bent ever so slightly (fig. 1-9). This bending is called *diffraction* and is evidenced by the formation of a shadow with a fuzzy edge when light passes an opaque object. In this case, the outside edge of the shadow is light and indistinct, but it gradually darkens into the true black of the shadow that indicates that some of the light is scattered into the shadow area.

Unlike refraction, in diffraction the long wavelengths of light are bent the most.

Diffraction is important to the photographer when the light passes the edges of a lens diaphragm. When the lens diaphragm is opened fully, the amount (actually the percentage) of diffracted light is quite small. But when the diaphragm is closed to a small opening, the percentage of diffracted light is quite large and reduces the sharpness of the image formed by the lens. In other words, a small aperture opening interferes with the image-forming light more than a large aperture does.

POLARIZATION

Energy in the form of wave motion radiates from its source and travels through a medium. For example,

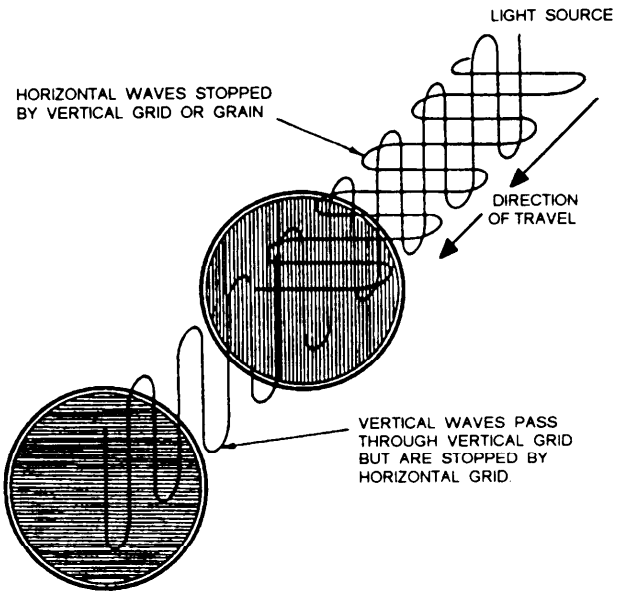


Figure 1-10.–Controlling polarized light.

when a section of line is secured at one end and the free end is held in your hand and given a shake, a wave travels down the length of the line from the end that was shaken to the secured end just like an oscillator. A light source acts as an oscillator. The wave motion in the line, however, does not represent the true wave motion of light because light waves move in all possible directions at right angles to their direction of travel. A much clearer picture of light wave motion can be seen by having a number of parallel lines with each one being shaken in a different direction-one up and down, one sideways, and the others at various angles in between.

Ordinarily, light waves vibrate in all directions at right angles to their direction of travel. However, when light waves strike a series of parallel microscopic slots, all the light that passes through vibrates in one direction. This is *polarized light.* Filters that polarize light, termed *polarizing filters,* have a practical use in photography (fig. 1-10).

Specular reflected light, from a nonmetallic surface at any angle between 32° and 37°, is polarized in such a manner that the light rays vibrate in a direction parallel to the reflecting surface. Light reflected in this manner is said to be *plane polarized* and is seen as glare (fig. 1-11). There is no polarization whatsoever produced by reflections from metallic surfaces.

LIGHT SOURCES

In the beginning of photography, daylight, or sunlight, was the only light source suitable for exposing the slow film available at that time. Today, photographic film is not only vastly more sensitive to light, but a wide range of light sources have been developed for the needs of the photographer. These light sources include the following: tungsten lamps, tungsten-halogen lamps, fluorescent lamps, and electronic flash.

DAYLIGHT

Sunlight, of course, is the light photographers are most familiar with and for good reason. It is the light they use the most. Naturally, sunlight is the only practical light source for general outdoor photography. Artificial light sources, however, can provide useful supplementary lighting to sunlight as fill-in for shadows (to make them lighter) and take the place of sunlight entirely for photography of small areas and close-ups. Sunlight is often referred to as daylight. The term *daylight,* as used in photography, is meant to include all

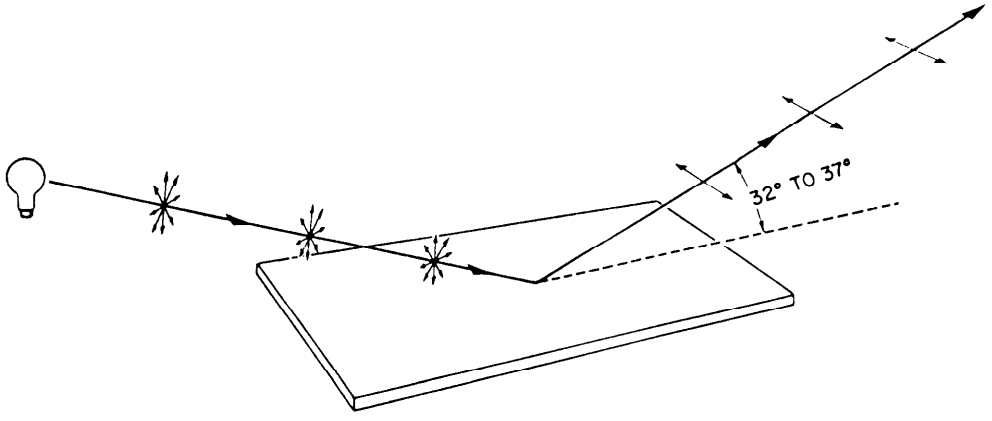


Figure 1-11.–Light, plane polarized by reflection.

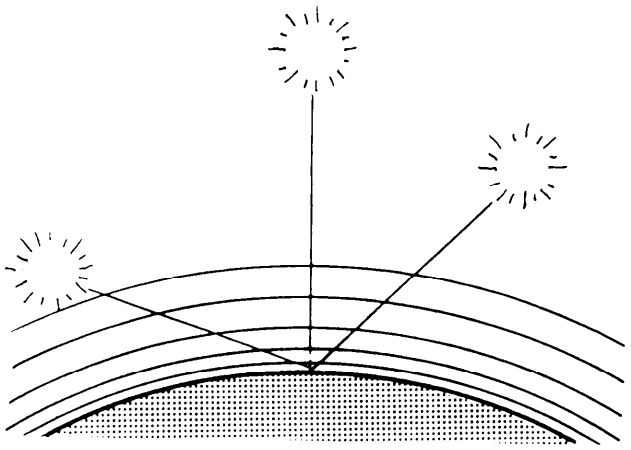


Figure 1-12.–Effects of sunlight passing through the atmosphere.

forms of light, direct or indirect, that originate from the sun.

Of importance to the photographer is the effect of the atmosphere on sunlight and the amount of atmosphere through which sunlight passes (fig. 1-12).

The shorter wavelengths of light (violet and blue) are scattered by the atmosphere much more than the longer wavelengths. The color composition of sunlight becomes increasingly deficient in blue the further the light has to travel through the atmosphere (early morning and late afternoon). As the sunlight becomes more deficient in blue, it appears more yellow. The amount of scattering also depends on the condition of the atmosphere. When the atmosphere is clean (has little moisture or fine dust in it), there is less scattering than when the atmosphere is hazy or dirty (having a good deal of moisture or tine dust and smoke). The variation in color of sunlight can be expressed as color temperature. Sunlight coming from overhead on a clear day has a color temperature of about 5400 K. Just after sunrise and just before sunset, the color temperature ranges between 2000 K and 4000 K. Not only is the color of sunlight different early in the morning and late in the afternoon, but the intensity is also less. These arc important considerations when taking pictures at these times of day.

Light scattered by the atmosphere, or *skylight* as it is called, can be regarded as a second source of light. Skylight is different than sunlight because it is caused chiefly from the scattering of the shorter wavelengths. It therefore appears more blue than sunlight. Skylight on a clear day may be as high as 60000 K.

ARTIFICIAL LIGHT

The types of artificial lighting you use in photography give you complete control over the direction, quality, and strength of the light. You can move these light sources around, diffuse them, or reflect them. You can alter their intensity to suit the situation.

There are two types of artificial light sources: *spotlights* and *floodlights*. Spotlights provide a concentrated beam of light. Floodlights give diffused, softer, more even, spread out light. You can add to these two basic types of artificial light sources. By using lighting accessories, such as reflectors, barn doors, diffusers, and snoots, you can control the light to provide a variety of lighting effects.

Unless special effects are wanted, artificial light sources that are different in color temperature or quality should not be mixed (used together). When you are viewing a scene, your eyes adapt so color differences between two or several light sources are minimized. Color film, however, cannot adapt and shows the color difference in parts of the scene illuminated by different light sources.

Tungsten-Filament Lamps

Tungsten light color films are made to be used with tungsten-filament light sources and are color balanced for 3200 K or 3400 K. Tungsten lamps, operated at their rated voltage, produce light of 3200 K and 3400 K. The color temperature of tungsten lamps changes with voltage fluctuations, decreasing with lower voltage and increasing with higher voltage. For example, the color temperature of a tungsten lamp rated for operation at 115 volts increases about 10 K for each 1 volt increase. Usually, a variation of less than 100 K has no adverse effect on the rendering of scene colors. However, a shift as low as 50 K can be noticeable on subjects with important neutral areas, such as white and light shades.

When you are using tungsten lamps, the color temperature can shift, depending on the amount of power being drawn on the same circuit. When possible, you should avoid having other equipment on the same circuit. For these lamps to produce light of the correct color, they must be operated at exactly their rated voltage. When it is not possible to operate the lamps at their proper voltage appropriate filters can be used to correct the color of the light reaching the film.

Tungsten-Halogen Lamps

Tungsten-halogen lamps have a tungsten filament inside a quartz envelope. This type of lamp does not blacken the inside of the envelope and operates at an almost constant brightness and color temperature throughout its life. Tungsten-halogen lamps for photography operate at color temperatures of 3200 K and 3400 K. Filters can be used to convert them to *daylight.* For its size, a tungsten-halogen lamp generally delivers more light than a conventional 3200 K lamp. Tungsten-halogen lights are becoming more popular and are rapidly replacing regular tungsten lights for general photographic use.

Fluorescent Lamps

Pictures made on *daylight* type of color films under fluorescent lights without a filter may be acceptable; however, they usually have a greenish cast. When a *tungsten* type of color film is used with a fluorescent lamp without a filter, the pictures usually are too blue.

Fluorescent light is not generated by heat, as are other types of light. It has special characteristics different from either daylight or tungsten light. Fluorescent lights have no true color temperature, but a value of approximate color temperature has been worked out.

- Daylight fluorescent lamps: 6500 K
- Cool, white fluorescent lamps: 4500 K
- Warm, white fluorescent lamps: 3500 K

Electronic Flash Lamps

Electronic flash is an excellent light source for both outdoor and indoor photography, especially when the predominant lights are fluorescent. Electronic flash uses a discharge tube filled with xenon gas and is supplied with a powerful charge of electricity from a capacitor. The flash is *triggered* by means of an electrical current that ionizes the gas. The output, or intensity of the flash, is usually given in effective candlepower-seconds and depends on the voltage and size of the capacitor. The design of the reflector on an electronic flash has a direct relationship on the efficiency of the unit.

Electronic flash resembles daylight in color quality and is excellent for exposing daylight type of color films. The duration of the flash is short, usually 1/500 second or less. With a computerized (automatic) unit used close to the subject, the flash duration can be as short as 1/50,000 second. Computerized electronic flash units have a sensor that switches off the flash when the subject (depending on its distance and tone) has received enough light for proper exposure.

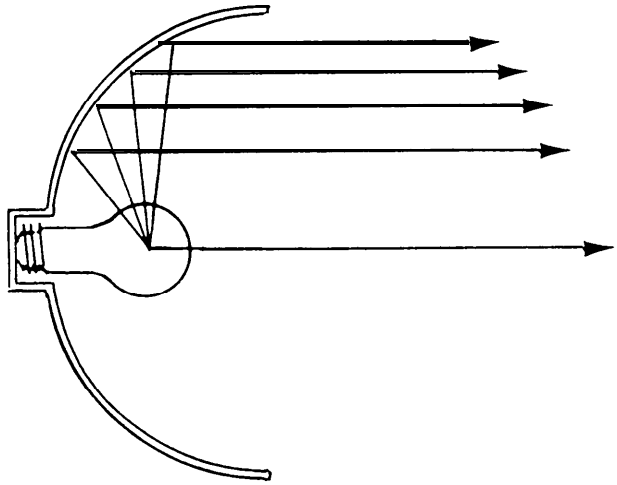


Figure 1-13.–A lamp reflector can increase the intensity of light reaching the subject.

Reflectors

Two types of reflectors are of importance in photography. They are the *lamp reflector* and the *plane reflector.* The first type, the lamp reflector, is used with artificial light sources-tungsten, tungsten-halogen, fluorescent, and electronic flash lamps to direct the light. The second type, the plane reflector, is used to *redirect* light from any kind of light source into shaded areas to soften or lighten shadows. (While it is true that mirrors are also reflectors, *reflector* is used in photography as a more general term. Mirrors always reflect specular light; and reflectors reflect either specular or diffused light.)

LAMP REFLECTORS. –Light emitted by the filament of a lamp is dispersed in all directions. This is useful when the lamp is for general illumination, such as one suspended from the ceiling to light a room. As a photographer, however, you are usually interested in illuminating only a given area, and it is, therefore, to your advantage to concentrate the light emitted by a lamp onto the area of interest. You can do this by mounting the lamp in a concave reflector that reflects almost all the light onto the area to be photographed (fig. 1-13). Lamp reflectors generally have a satin or matte finish to diffuse the reflected light to prevent hot spots that could result if the reflector surface were highly polished.

Reflectors of electronic flash units vary considerably in their efficiency and covering power at

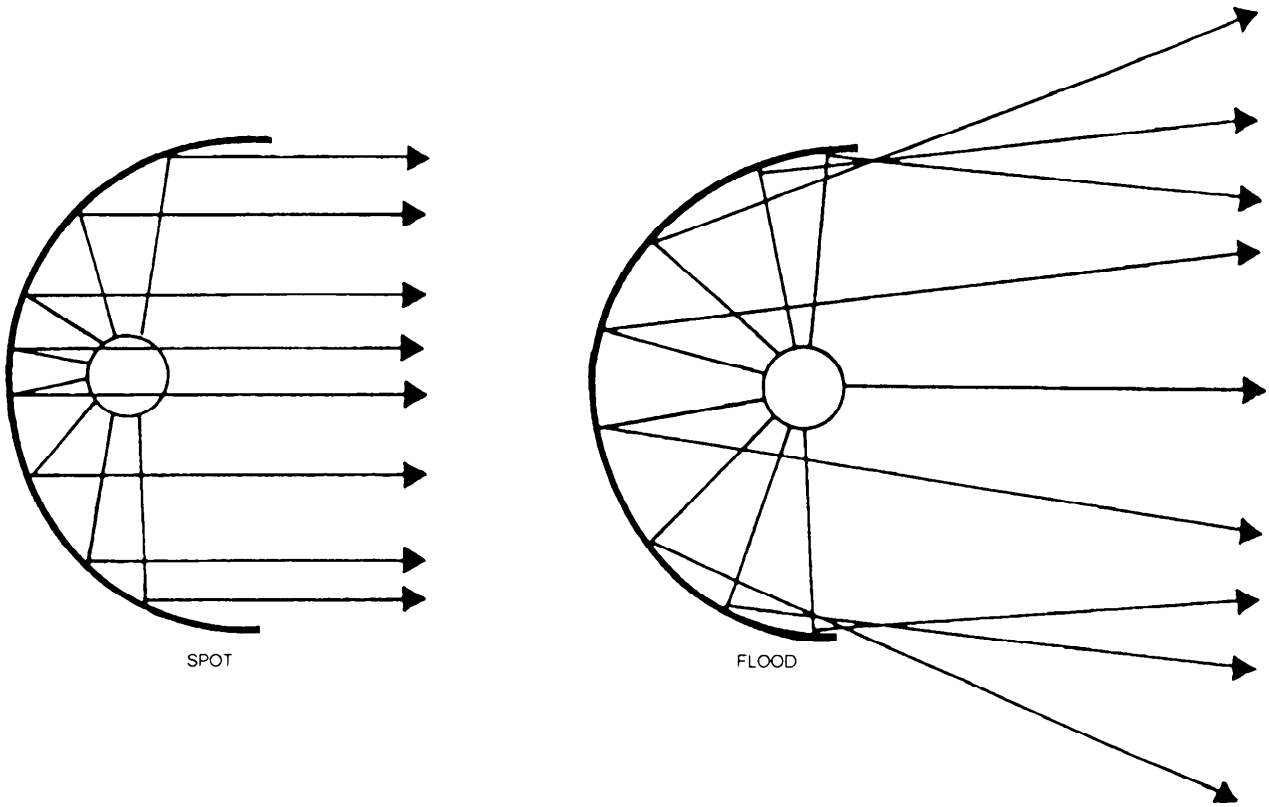


Figure 1-14.-The position of the discharge tube in relation to the reflector.

different distances from the subject. Generally, they are designed to provide maximum efficiency at distances of from 6 to 12 feet from the subject. Professional type of electronic flash units may have a dual reflector system-one position for a normal angle and the other for a wide angle (for a wide-angle lens); others may have a zoom system to provide optimum light distribution for any lens within a wide range of focal lengths. Depending on the position of the discharge tube in relation to the reflector, the unit can be used as a spotlight or floodlight (fig. 1-14).

PLANE REFLECTORS. –When you want to provide fill-in light for shadow areas, it is often desirable to substitute a plane reflector (sometimes called a reflector board) to redirect the light from a direct light source (fig. 1-15). The plane reflector is placed so it receives light from the primary light source and reflects the light into the shadows. The efficiency of such a reflector depends on its surface and tone, as well as size and distance from the subject being photographed. The subject area covered by a plane reflector depends on the size of the reflector. When the surface of the reflector is matte or textured, it reflects diffused light and some of the reflected light is dispersed over a wide angle.

OPTICAL PRINCIPLES

Cameras have optical systems, or lenses, made up of several separate pieces of glass, called *elements.* There are two reasons for having several elements. First, it allows the designer to make many different types of lenses to suit different purposes. Second, the quality of the image formed by the lens can be controlled by choosing different lens elements. The most important choices the lens designer makes are the shape and position of each lens element. These govern properties like focal length, angle of view, physical weight, and size.

Lenses are probably the least understood but the most discussed component of the photographic process. Photographers (generally amateurs) speak of a lens formula as if they knew what it was about. Even if the designer's formula were made available, it would not provide information about the lens photographic quality. A perfect lens cannot be made. A lens is a compromise of inherent errors called *aberrations,* but do not let this worry you. Lens aberrations are defects in the formation of an optical image. Today's lenses are so highly corrected for lens aberrations that, except for a few ultra wide-angle (fisheye) lenses, you would be hard pressed to find a lens that produces subjectively identifiable

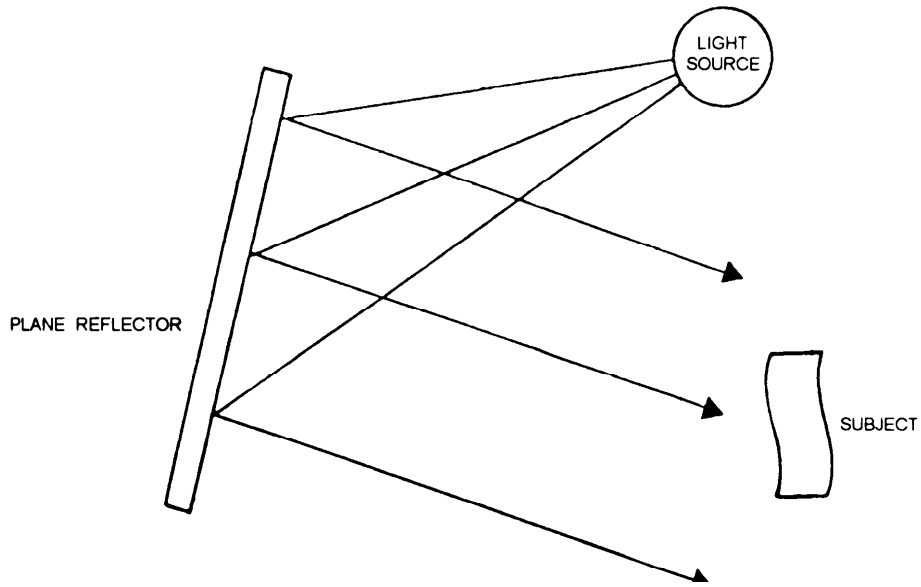


Figure 1-15.–Plane reflector and subject coverage.

aberrations. You may hear photographers talking about aberrations as if they were important. They may make an interesting subject, but knowing all the details about them does not help you to take better photographs. Important matters that will improve your skill as a photographer are knowing how to control the factors, such as exposure, composition, lighting, and lab work. Let the lens designers and manufacturers worry about the lens aberrations. However, just so you know what these lens aberrations are, a brief definition is provided for each of them in the glossary; they are as follows:

- Astigmatism
- Chromatic aberration
- Coma
- Curvilinear distortion
- Spherical aberration

Today's lenses can image more detail than present film materials can record. Therefore, avoid discussing *lens* resolution. If you want to discuss resolution, talk *film* resolution.

PRINCIPLE OF A LENS

The purpose of a camera lens is to control the light rays entering the camera. The simplest kind of lens is a pinhole in a piece of thin metal or black paper. Of course, only an extremely small part of the light reflected by a subject passes through the pinhole and enters the camera. When the pinhole is large, it allows more light rays to enter but blurs the image. This blur is really an overlapping of several images. Images produced by large and small pinholes are the same size, but one is blurred, while the other is sharp. A photographic lens is a piece of polished and carefully shaped glass that *refracts* light rays so an image of a desired scene is formed on the rear wall of a camera. A lens transmits more light than a pinhole. It increases the brightness and improves the sharpness of an image. The basic principle of a lens-any lens-is relatively simple.

First, consider an image formed with a single pinhole. Next, consider another pinhole above the first. This pinhole forms a second image. When these two images could be made to coincide, the result would be an image twice as bright as the original. Now, consider a third pinhole on the side of the first, a fourth on the other side, and a fifth below the first. All four pinholes project separate images slightly removed from the first or center one. When these four images are made to coincide with the center one, the result is an image five times as bright as the image made by the one center pinhole. By using the principle of refraction, you can make these four images coincide with the center one. By placing a prism behind each pinhole, you are causing the light that forms each of the four images to be refracted and form a single image. In other words, the more pinholes and prisms used, the brighter or more intense the image. A lens represents a series of prisms

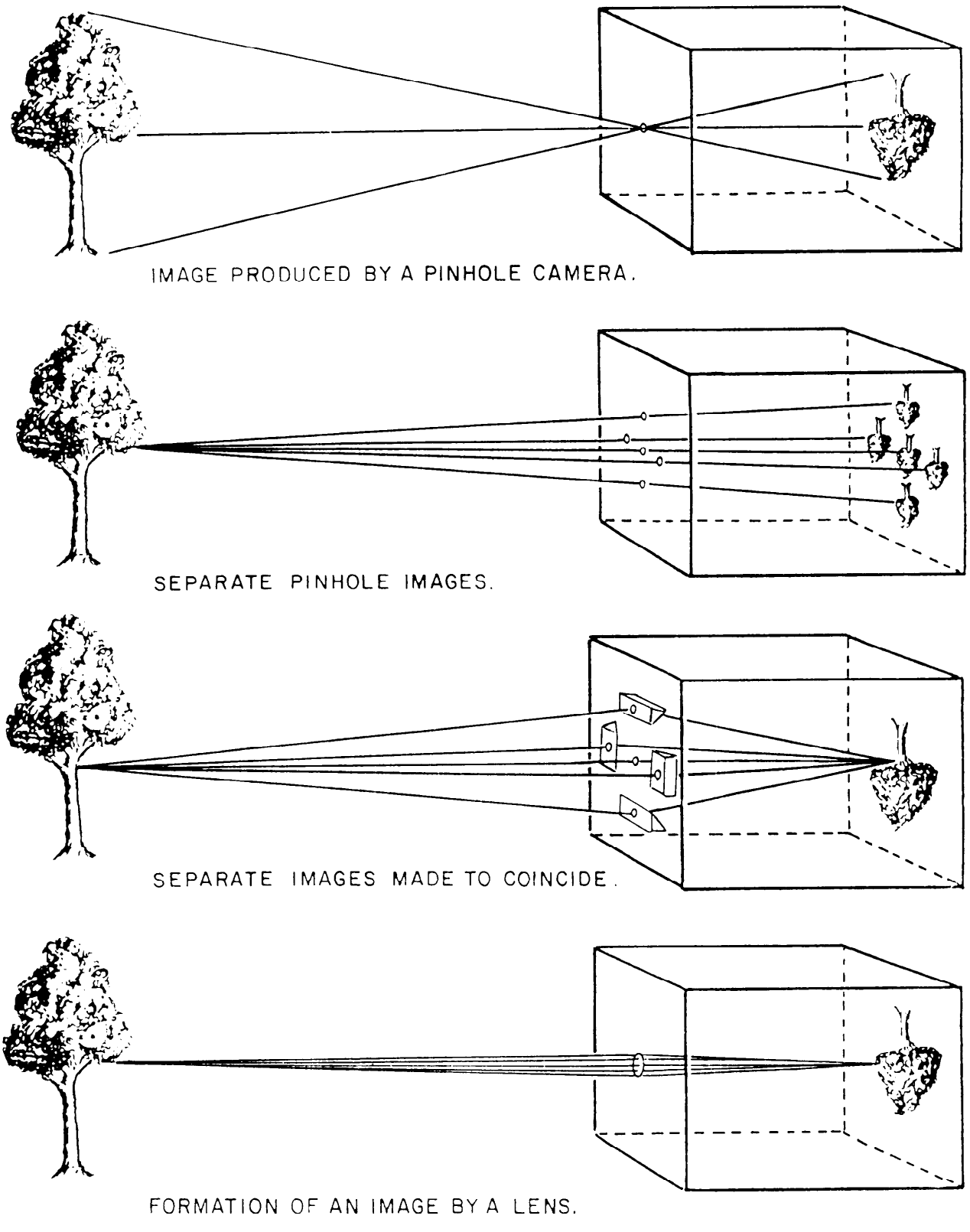


Figure 1-16.–Formation of an image by a lens.

incorporated in a single circular piece of glass (fig. 1-16).

CHARACTERISTICS OF LENSES

There are several factors that must be included when you are considering the characteristics of lenses. To perform well as a Navy photographer, you must recognize the effect of these lens characteristics. Realize also that it is the recognition and use of these various lens features and/or qualities that can make the difference between good and poor photography. You must learn to recognize the photographic effect of these characteristics and be able to apply them to produce top quality photography. Finally, you must learn how some of the lens characteristics may limit photographic quality or operational capability.

Lens Focal Length

In photography, lens focal length is the distance between the optical center of a lens and the focal plane (film plane) of the camera when the lens is focused at infinity (fig. 1-17). To understand this definition, you must fully understand the terms *focal plane, optical center,* and *infinity.*

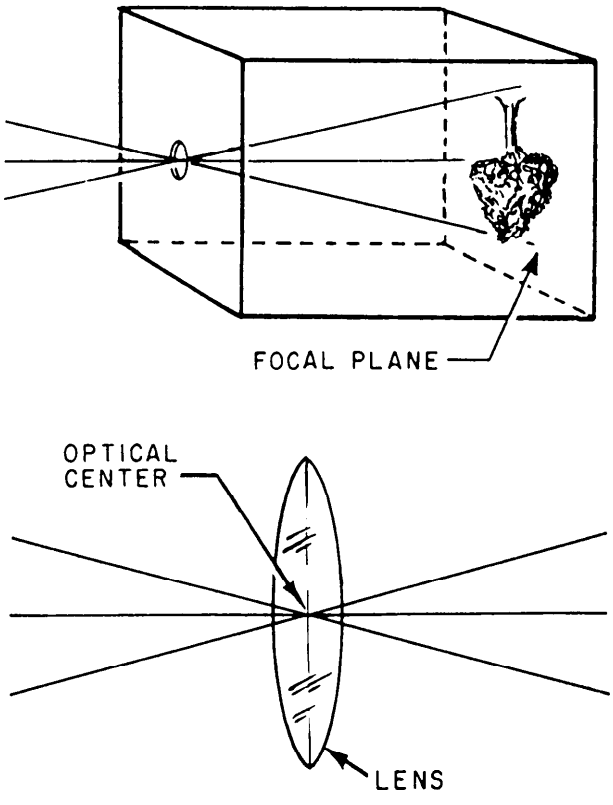


Figure 1-17.–Focal plane and optical center.

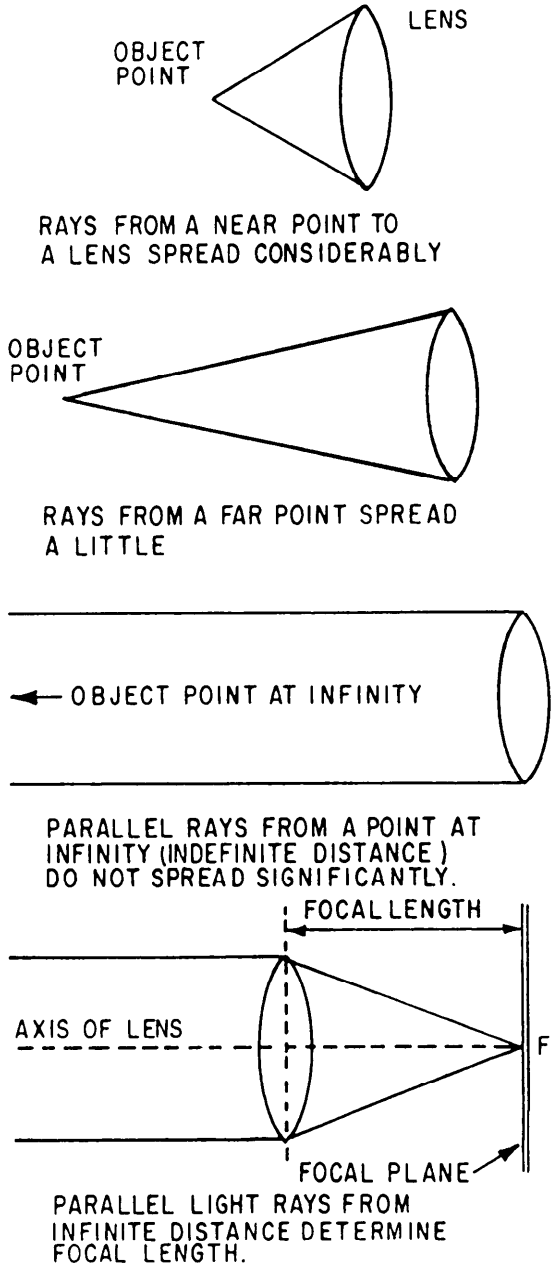


Figure 1-18.–Effects of lens-to-subject distance on light rays.

- Focal plane-The surface (plane) on which an image transmitted by a lens is brought to sharp focus; the surface or area at the back of the camera occupied by the film.

- Optical center-The optical center of a lens is a point, usually (although not always) within a lens, at which the rays of light from two different sources entering the lens are assumed to cross.

- Infinity-This term is not easily described. When light is reflected from the point of an object, the closer the point is to the lens, the greater is the angle of the spread of light rays from the object (fig. 1-18). As the

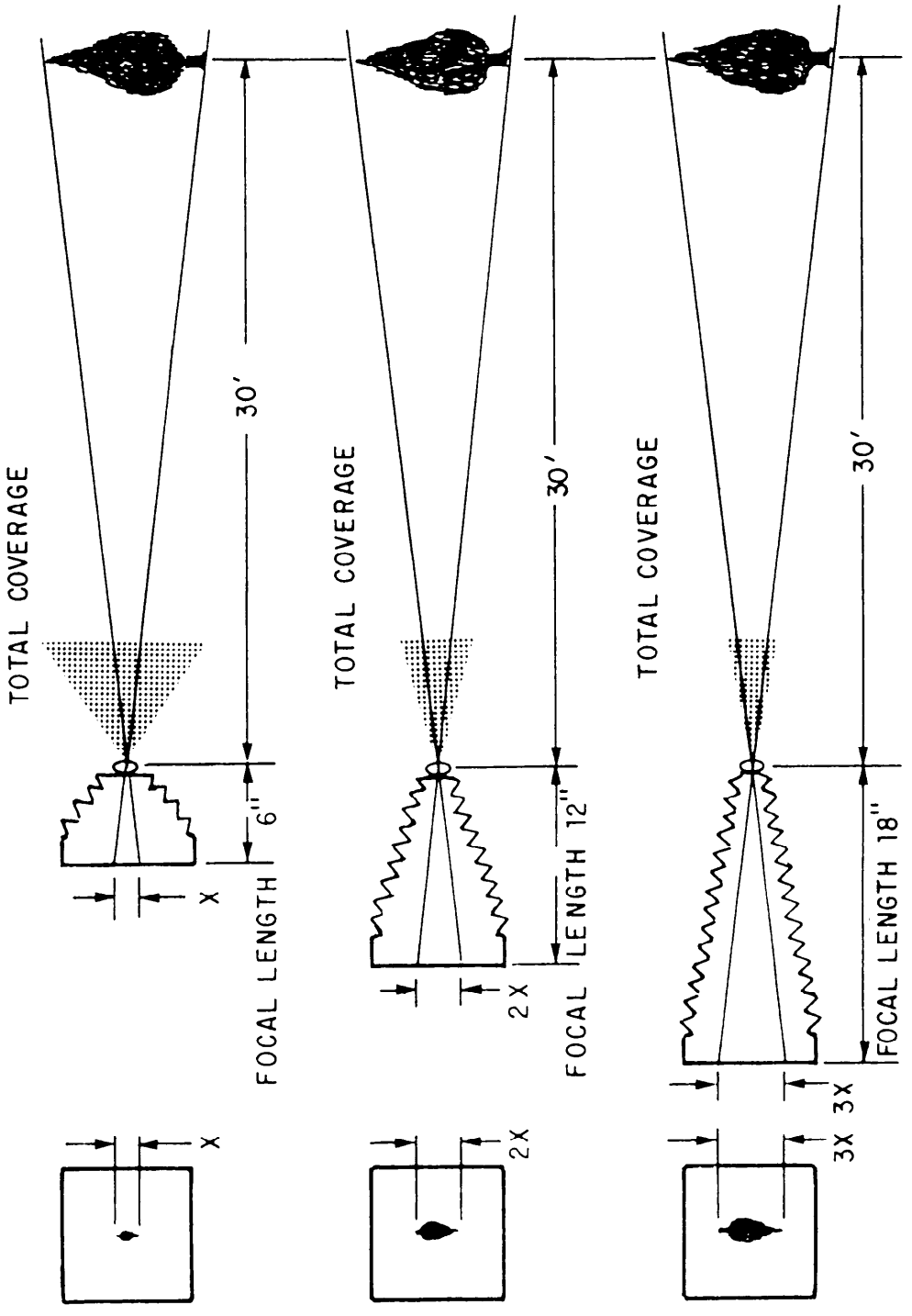


Figure 1-19.–Image size and coverage as compared to the lens focal length.

object point gets farther away from the lens, the angle of spread becomes less and less until a distance is reached at which the rays from a single point, for all practical purposes, can be considered parallel. This distance is known by the term *infinity*. For all practical purposes, light rays from a distant object or an object at 600 or more feet away may be considered to be parallel. But this is only for practical purposes. When very long focal-length lenses or telephoto lenses are being considered, the distance of 600 feet may be much less than infinity. In other words, infinity is a distance so far removed from the camera lens that the rays of light reflected to the lens from a point at that distance may be regarded as parallel. Infinity is expressed by the symbol ∞ and is a setting on a camera focusing scale.

The manner in which light rays are refracted by a lens determines the focal length. This refraction, in turn, depends on the nature of the glass used in the elements, the curvatures of the element surfaces, and the separation of the elements. The first two factors are fixed quantities once the lens is manufactured, but the third factor may be changed individually in certain lenses.

In *zoom lenses* the distance separating the lens elements can be changed. In convertible lenses, portions or elements of the lens can be used by themselves. In either method, the focal length of the lens can be changed. When one of these two conditions cannot be met, the focal length is fixed and constant.

Photographic lenses are measured according to their focal length which is normally imprinted somewhere on the lens mounting (usually the front surface of the lens barrel). This focal length information is sometimes given in inches, sometimes in millimeters, and occasionally in both systems. Focal length is frequently used to indicate the size of a lens. Thus, a lens labeled as an 8-inch lens indicates that when it is focused on a point at infinity, the distance from its optical center to the focal plane is 8 inches.

The focal length of a photographic lens dictates the size of the image produced by the lens at a given lens-to-subject distance. Focal length also determines the minimum distance between the lens and the focal plane. The normal focal length of a lens (normal lens) for a camera is approximately equal to the diagonal dimension of the film being used. Since the diagonal dimension of a 4x5 film is 6.4 inches, a lens about 6 inches is a normal lens for such film.

Lenses with a longer than normal focal length may be used on a camera, provided the distance from the lens to the film can be increased sufficiently to accommodate the increase in focal length. Lenses shorter than the normal focal length may also be used, provided they are designed to meet the constraints of the camera and film size.

FOCAL LENGTH AND IMAGE SIZE.–When you photograph the same object at the same distance, a lens with a long-focal length produces a larger image than one with a short-focal length. In effect, the longer focal-length lens magnifies or brings the subject closer to the camera without changing the camera-to-subject distance (fig. 1-19). For example, a man 6 feet tall stands at a distance of 25 feet from three cameras, one equipped with a 6-inch lens, one with a 12-inch lens, and one with a 24-inch lens. The 6-inch lens produces a 1 1/2-inch image of the man. The 12-inch lens produces an image that is 3 inches high. The 24-inch lens produces a 6-inch image. From this example, it is obvious that the longer the focal length of the lens, the larger the image size of a given object from a given lens-to-subject distance.

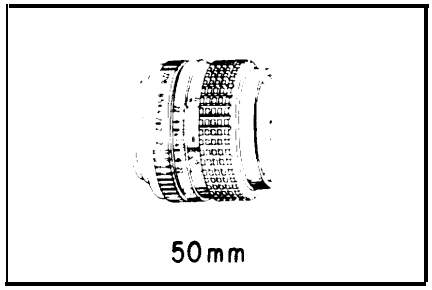
FOCAL LENGTH AND SUBJECT COVERAGE.–Focal length and subject coverage go hand in hand-just as do focal length and image size. But, whereas image size increases with increased focal length, coverage decreases with increased focal length. We can consider coverage as the amount of subject matter included in a given format film size from a given lens-to-subject distance. With two cameras-each with a different focal-length lens-at the same distance from the same subject, the camera with the shortest focal-length lens includes the greatest subject area-the camera with the longest focal-length lens the least subject area (fig. 1-20).

Angle of Field.–The focal length of a lens is a determining factor in the coverage of that lens. The maximum coverage at the focal plane of a lens is expressed in degrees as the *angle of field.* Angle of field is the widest angle at which light entering a lens produces a usable portion of the *circle of illumination* at the focal plane. Light around the edges of the entire circle falls off in intensity before disappearing completely. The usable portion of this circle is called the *circle of good definition.*

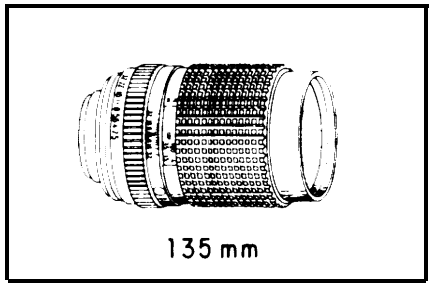
The maximum size of film you can use with a lens depends on the angle of field because any part of the film outside the circle of good definition produces an indistinct image.

Angle of field is a basic optical condition that is approximately equal for all normal focal-length lenses. A normal lens, as it is called, has an angle of field of about 45 degrees to 55 degrees. This angle of field

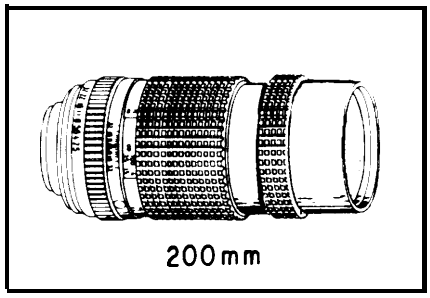












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Figure 1-20.–Subject coverage compared to the lens focal length.

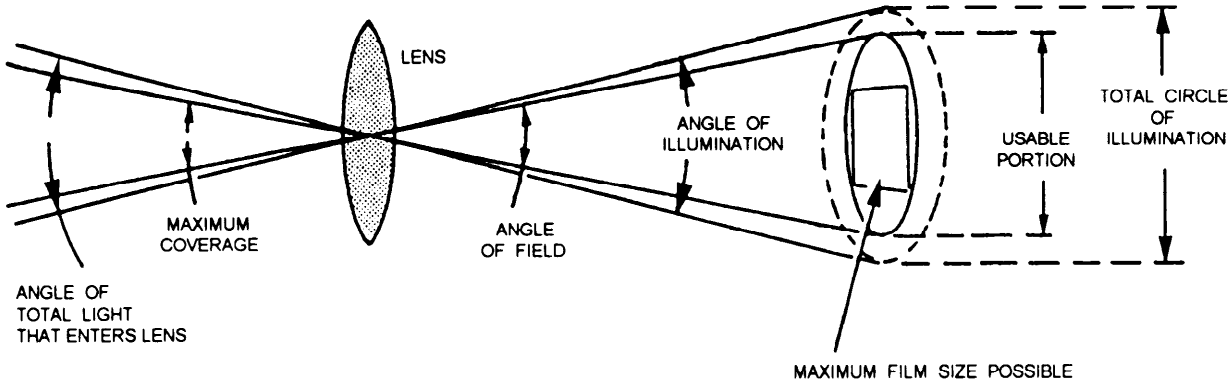


Figure 1-21.–Angle of field.

closely resembles the central vision coverage of the human eye. Wide-angle lenses have a large or wide angle of field Long focal-length lenses (often called telephotolenses) have a narrow angle of field (fig. 1-21).

Angle of View.–Angle of view determines the coverage of a lens with a particular size of film, with the lens-to-film distance remaining unchanged. Angle of view is an angle with the intercept point at the lens and its sides matching the corners of the film.

The angle of view (fig. 1-22) of a normal focal-length lens with a given film size can approach but never exceed the angle of field of the lens. Any lens recording an angle greater than 55 degrees with a given film size has a short-focal length and is called a wide-angle lens. Any lens with an angle of view less than 45 degrees with a given film size has a longer focal length.

Lens Diaphragm

The diaphragm of a lens is an opening in the lens that allows light to pass through it to expose the film (or other recording medium). This opening can be made larger or smaller to allow more or less light to pass through the lens. When the diaphragm opening is very large, only the object that the lens is focused on is in sharp focus. As the diaphragm opening is reduced (made smaller), more objects in a scene, both in front and behind the point of focus become sharper. The lens diaphragm is used in conjunction with the shutter of the camera to control the amount of light to expose the film.

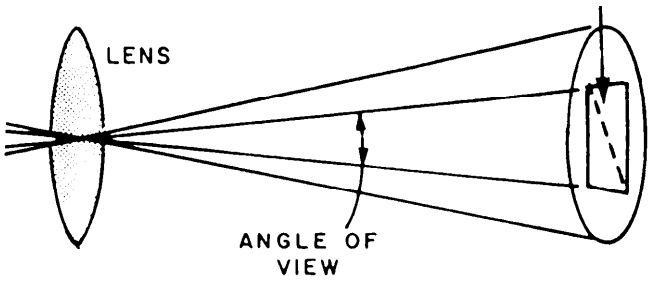


Figure 1-22.–Angle of view.

PERSPECTIVE

The human eyes see objects in three dimensions, but a lens reproduces a view in two dimensions. The missing dimension, depth, is suggested by the relative size and position of the various objects in a picture. *Perspective,* which is the relationship of objects in a photograph, affects the naturalness of a picture. Good perspective represents objects as they actually appear to human eyes.

Since wide-angle lenses take in a greater area, most photographers use them to photograph in tight quarters. And they use long-focus (long focal length) lenses to bring distant objects closer. This is fine, but it is only part of the story. Lenses of different focal length are also used to control perspective.

Perspective is NOT dependent on the focal length of the lens. It is a function of camera-to-subject distance. But a choice of lenses of a different focal length does enable you to get the desired image size at the selected distance for best perspective. For example, suppose you come across a placid farm scene. A rustic rail fence is in the foreground, and a cow is munching on a haystack in the field. The cow and her lunch are 100 feet behind the fence; you are 10 feet in front of the fence. The fence is essential to your picture and you use a 50mm lens. The result! The cow is 110 feet from the camera and is too small in relation to the fence. Your picture is a flop. Now change your perspective. Back up 40 feet from the fence

and use a 200mm lens. The fence at this distance, with the 200mm lens, is the same size as it was at 10 feet with the 50mm lens. The cow is now 140 feet from the camera, but her image is four times larger. In the photograph, it looks as if she were only 35 feet away or 25 feet behind the fence. The results! An interesting picture and pleasing composition. Choosing viewpoint and then selecting focal length for image size is one of the most important functions you should consider when selecting lens focal length.

HOW TO USE LENSES

Today, the Navy photographer is applying photography to the ever-widening specialized and technical fields within the modem Navy. This has led to greater emphasis on the correct and accurate use of the most important part of the camera-the lens. The higher standards of picture quality and the greater interest in picture taking regardless of lighting conditions, all demand more attention to the correct use of lenses. No matter how good the quality of the lenses, if photographers do not use them correctly, they will not do us or the Navy any good.

f/stop of a Lens

To use lenses correctly, the photographer must understand the relationship between the aperture of a lens and the brightness of the image produced at the focal plane. The *aperture* of a lens is simply the opening through which light passes. The aperture is controlled by an adjustable diaphragm or iris. Each setting of the diaphragm is called an *f/stop* and is always read as a number, not as a fraction or true ratio. It is referred to as the f/stop or the f/stop of the diaphragm opening. This value is designated by a lowercase f with a slant (/) between the f and the value. For example, f/8 means that the diameter of the opening in the diaphragm is one eighth of the lens focal length, but only "when the lens is focused on infinity." In this example f/8 is the effective aperture. If the lens were focused at other than infinity, f/8 would then be the *relative* aperture. In the study of the relationship between aperture and image brightness, the term *relative aperture* is used frequently. The term *relative aperture* then refers to the ratio between the *effective aperture* of the lens and its focal length. The relative aperture of a lens is controlled by two factors: (1) the diameter of the beam of light passed by the lens; and (2) the focal length of the lens, which governs the size of the area over which the light is spread.

f/stop Applications

The formula to determine the f/stop of a lens is as follows:

$$f = \frac{F}{D}$$

Where:

F = focal length

D = diameter of the effective aperture

f = f/stop, or the relative aperture

EXAMPLE: To find the f/stop of a lens that has a focal length of 8 inches and the diameter of the effective aperture is 2 inches, use the formula below.

$$f = \frac{F}{D}$$

$$f = \frac{8}{2} \text{ or } f = 4$$

Therefore, the lens has a relative aperture of f/4.

When the diameter of the opening (aperture) of the lens is made smaller, less light is admitted and the image formed by the beam of light passing through the smaller opening becomes dim. As the size of the opening is reduced, the ratio between the aperture and the focal length increases. Thus an inverse relationship exists between the E/number and the relative aperture; as the f/stop becomes larger, the size of the relative aperture decreases.

Since the f/stop is a ratio of focal length to the lens diameter, all lenses with the same f/stops regardless of focal length provide the same amount of light on the focal plane; that is, when all the other factors that affect image brightness remain constant (fig. 1-23).

DIAPHRAGM

There is in every lens assembly a mechanical device for controlling the amount of light that passes through the lens. This mechanism may have a fixed size, or it may be designed to provide a selection among a number of sizes that can be given to the aperture in a lens. This device is a *diaphragm,* and its scale increments are called f/stops (fig. 1-24). It is located within the lens to cut off or obstruct the marginal light rays while permitting the more central rays to pass. Most lenses have a series of thin metal leaves for this purpose. These leaves are arranged and shaped to provide an approximately circular opening that can be changed in

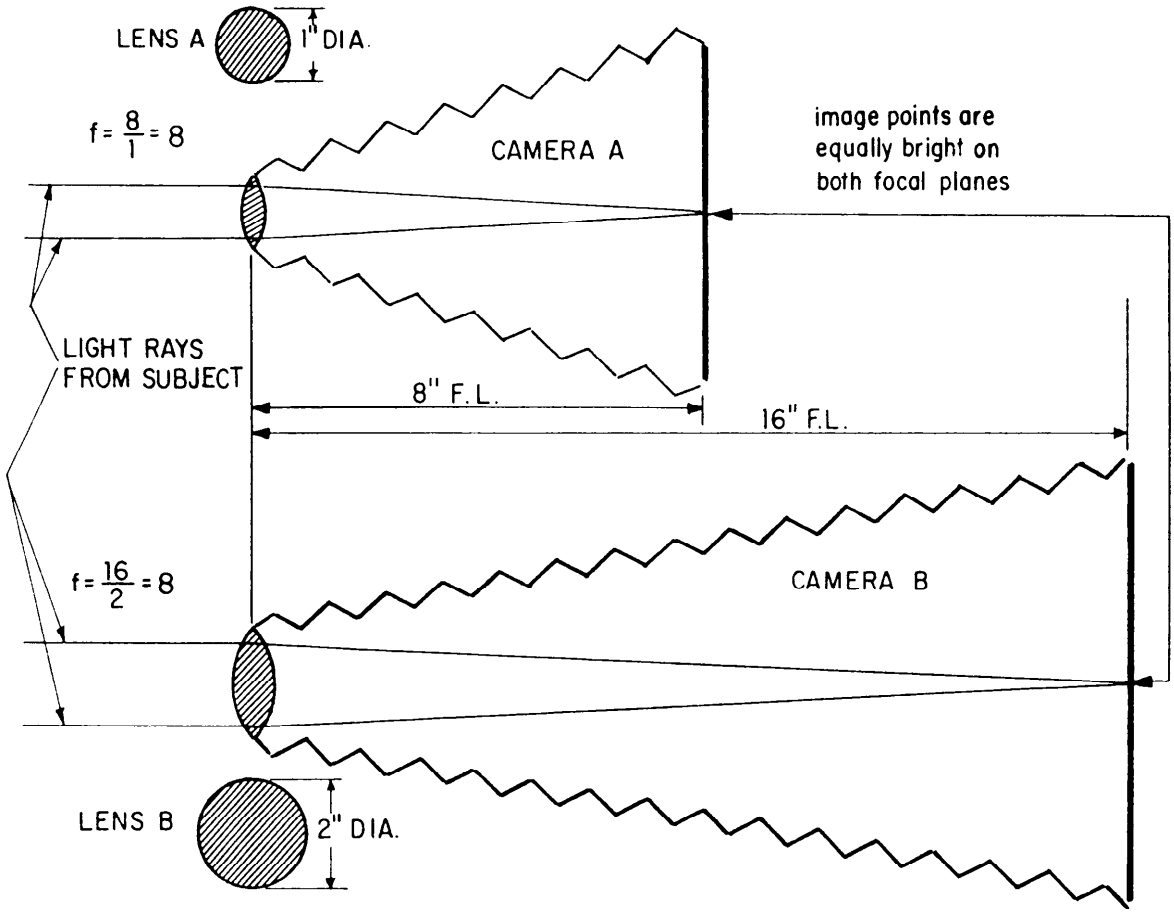


Figure 1-23.–Equal f/stops produce equal intensities.

size, when desired, and is called an iris diaphragm. This opening is always concentric (centered) with, and perpendicular to the optical axis of the lens. Its location in the lens barrel is determined by the manufacturer when the lens is designed.

Rotating the diaphragm control ring in the direction that reduces the size of the aperture is termed *stopping down.* Moving the control ring so it enlarges the aperture size is termed *opening up.* When the diaphragm is set at the largest aperture, the lens is said to be *wide open. The* better the quality of the optics within the lens, the larger the possible maximum aperture. The size of the largest opening is the maximum working aperture of the lens and is called the *lens speed.* The diaphragm, along with the shutter, controls the amount of light passing through a lens, and hence the exposure the film receives.

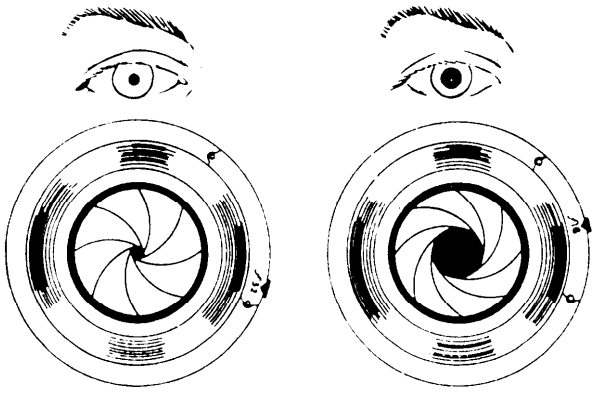


Figure 1-24.–Iris and iris diaphragm.

There are many different aperture sizes possible with the diaphragm, and each aperture size has a different value. Consequently, a system was devised for marking them so they could be used with consistency. The *factorial system* has become the most widely used. This system uses a set of markings commonly called the f/system. By using the diaphragm control ring, or lever, you can bring the index mark into line with the numbers that indicate the measured f/stop of the aperture. Remember, as these index numbers increase in size, the opening decreases in size. Furthermore, these numbers are chosen by moving the index pointer to the next larger number, and the amount of light admitted is cut in half. The first or lowest number in the series is usually an

exception. All these numbers may not exactly reduce the amount of light admitted by one half, but they are sufficiently close for all practical purposes. However, all of these values are in proportion to the squares of their numbers. For example, f/4 admits four times more light than f/8 because the square of f/4 is contained in the square of f/8 exactly four times. Thus,

$$4^2 = 4 \times 4 = 16$$

$$8^2 = 8 \times 8 = 64$$

$$\frac{64}{16} = 4$$

Table 1-1 shows that the amount of light admitted is inversely proportional to the square of the f/stop, while the exposure required is directly proportional to it.

EXAMPLE: The correct exposure at f/8 required 1 second. How long an exposure is required at f/16? The proportion and computation are as follows:

$$\frac{(\text{Old f/value})^2}{(\text{New f/value})^2} = \frac{(\text{Old exposure})}{(\text{Required exposure})}$$

$$\frac{8^2}{16^2} = \frac{1}{x}$$

$$\frac{64}{256} = \frac{1}{x}$$

$$64x = 256$$

$$x = 4$$

Thus the required exposure equals 4 seconds.

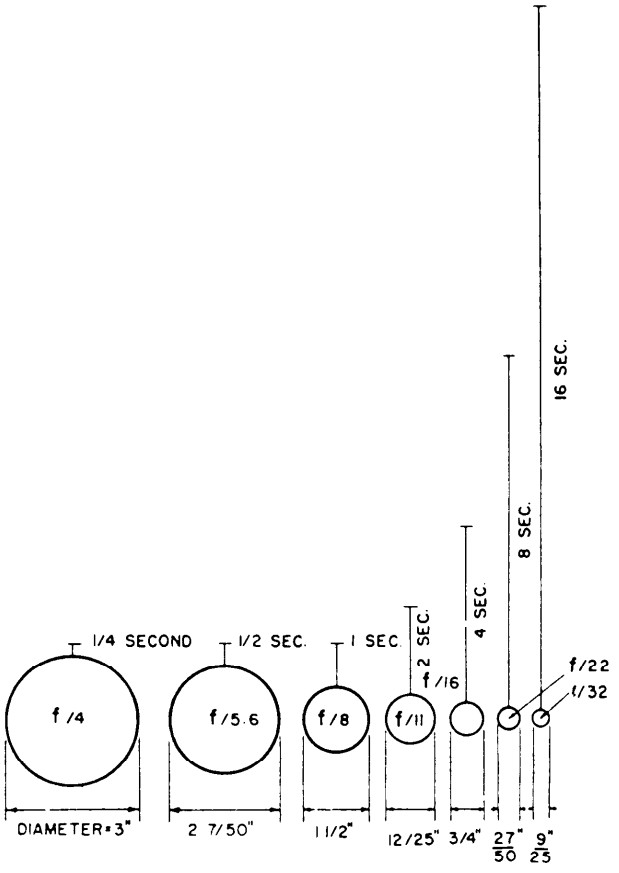


Table 1-1.–Comparison of f/stops with Amount of Light to Exposure Time

f/ value	f/value^2 squared	Amount of light admitted	Exposure in seconds
4	16	4	1/4
4.5 (half stop)	20.25	3.2	1/3
5.6	31.36	2	1/2
8	64	1	1
11	121	1/2	2
16	256	1/4	4
22	448	1/16	8
32	1024	1/32	16

Table 1-2.–Amount of light, f/stop, and Exposure Time Relationship

f/stop	Relative exposure	Relative amount of light admitted
1	0.06	16
1.4	0.12	8
2	0.25	4
2.8	0.50	2
4	1.0	1
5.6	2.0	1/2
8	3.0	1/4
11	8.0	1/8
16	16.0	1/16
22	32.0	1/32
32	64.0	1/64
45	128.0	1/128
64	256.0	1/256

The first (lowest) f/stop marked on the lens mount is the correct value for its largest aperture. The next number is the nearest f/stop in an arbitrary series that has been adopted as a standard. In this standard series, each succeeding number going up the scale (from the largest opening to the smallest) permits only half as much light to enter the camera. Thus, as the numbers get larger, the diaphragm openings (apertures) become smaller. However, moving the index pointer in the reverse order, down the scale (from the smallest opening to the largest), the numbers get smaller and the diaphragm openings become larger. As shown in table 1-1, the *smallest number* may not admit exactly twice as much light as the next larger number. Nevertheless, the amount of light admitted remains inversely proportional to the square of the f/stop, and the exposure required is always directly proportional to it.

All lenses are indexed with the standard series of f/stops either completely or in part-except for the first f/stop (as stated earlier) that is computed to indicate the correct value of the maximum aperture. The photographer should become acquainted with this series, so its relative values are known. The following table is a listing of the f/stop, better known as the standard full stops. A comparative exposure based on 1 second at f/4 or 16 seconds at f/16 is also shown (table l-2).

By studying the table, you can see that when the lens aperture is opened one full stop, the amount of light transmitted is twice that of the nearest preceding stop. And altering the f/stop one full stop less (stopping down) reduces the amount of light passing through the lens to one half that of the nearest larger stop.

In summary then:

- Light passes through an opening (aperture) of the lens. The diameter of the aperture can be changed. The openings are called f/stops. The f/stops indicate to the photographer that a lens (any lens) with a specific f/stop allows a given amount of light to the film. Thus a 12-inch focal-length lens set at f/4.5 gives the same exposure as a 6-inch focal-length lens set at f/4.5.

- The f/stops represent a fraction of the focal length of the lens for a given lens; that is, an f/4 lens has an effective maximum opening of one fourth of its focal length.

- From one full f/stop to the next full f/stop, there is a constant factor of two. As the opening changes from f/8 to f/l1, the light passing through the lens is reduced by one half because the larger f/stop (f/11) is a smaller aperture. When the aperture is changed from f/8 to f/5.6, the light passed is doubled because the aperture has been made larger.

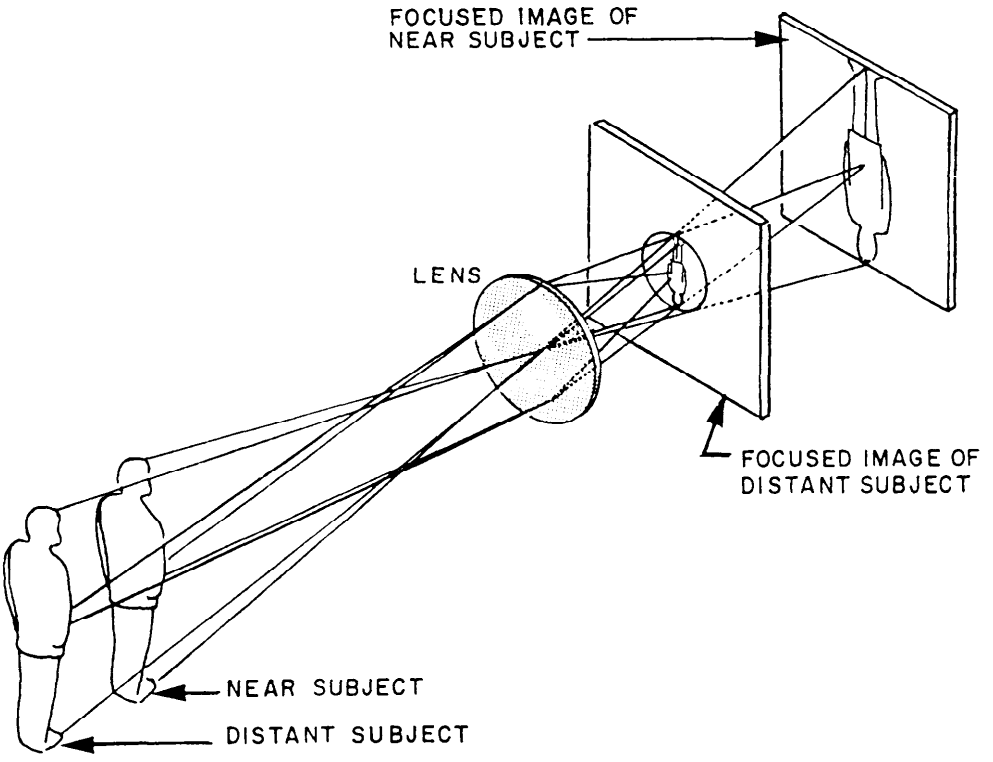


Figure 1-25.–Subject distance and focus.

f/stops Functions

f/stops have three functions:

1. They act as a partial control of exposure (the other exposure control is the shutter).

2. They help control depth of field.

3. They allow the photographer to adjust the aperture to the point of best definition of the lens, sometimes called the optimum or critical aperture.

Each of these functions is discussed in this chapter.

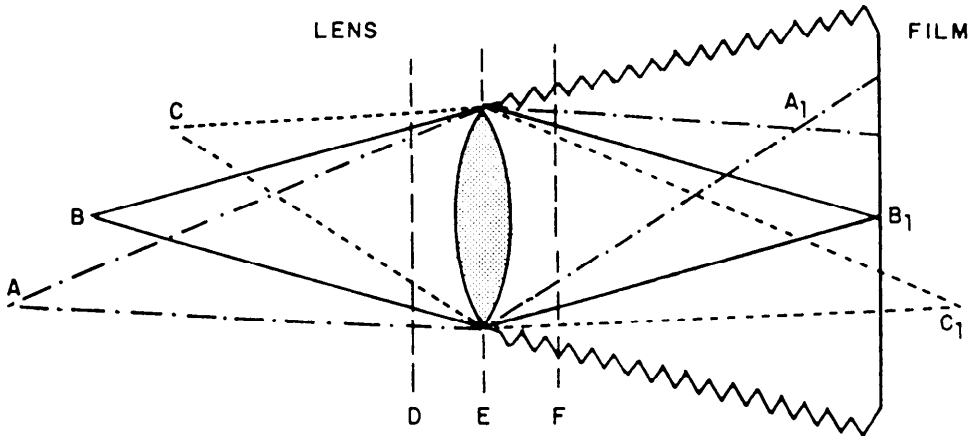
Focusing

A lens, at a given focus setting, provides a sharp image of an object at only one distance in front of it. However, when the distance between the focal plane and the lens can be adjusted, the lens can be made to form sharp images of objects located at differing distances in front of it. Therefore, to get a sharp image of a subject at a given distance, you must adjust the lens to the appropriate distance from the film plane. This adjustment is known as focusing.

In focusing a camera lens, the nearer the subject is to the lens, the farther behind the lens the image is formed. For close subjects, the lens must be moved away from the film plane to focus the image; and the farther away the subject is from the lens, the closer to the lens the film plane must be (fig. 1-25).

INFINITY FOCUS.–When the lens is focused on an object so distant that the light rays reflected from it are parallel, these rays converge (after refraction by the lens) at the *point of principal focus.* The point of principal focus is on the *principal focal plane;* that is, at a distance of one focal length behind the lens. Therefore, the lens is said to be on infinity focus.

When the distant object is moved nearer to the lens or the lens is moved closer to the object, the distance between the focal plane and the lens must be increased to keep the image in sharp focus. When the distance between the lens and focal plane is not extended as the object is moved nearer to the lens, the image of the object becomes blurred or out of focus. The closer the lens is to the object it is focused upon, the larger the image becomes until the distance between the lens and the focal plane is extended to twice the focal length of the lens. At this distance, the image and the object focused upon are the same size. Therefore, the size of an image formed by a lens is dependent upon two factors: the distance from the lens to the object focused upon and the focal length of the lens.



Light coming from the far object A passes through the lens to form a sharp image at A_1 and light coming from the nearer object C passes through the lens to form a sharp image at C_1. To obtain a sharp image of A, move the film to A_1 or move the lens to F. To obtain a sharp image of C, move the film to C_1 or move the lens to D.

Figure 1-26.–Focusing for one object.

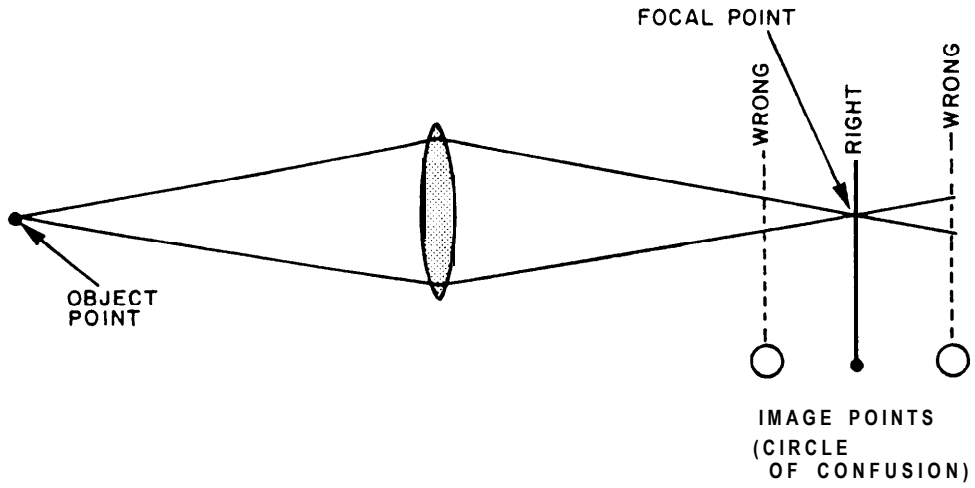


Figure 1-27.–Image on film in front of and in back of the point of sharp focus.

FOCUSING FOR ONE OBJECT.–Focusing is done essentially to obtain the proper distance between the lens and the film. When light rays come from a far object and pass through a lens, they form a sharp image close to the lens. When light rays come from a near object, they form an image farther away from the lens. This means that the lens must be focused on either the far or the near object, depending on which one the photographer wants to have in sharp focus. When a sharp image of the near object is desired, the lens should be focused by moving it farther away from the film. When you want a sharp image of the far object, move the lens closer to the film (fig. 1-26).

CIRCLE OF CONFUSION.–A picture is basically an accumulation of many points that are exact images of points composing the subject. After light strikes a subject, it is reflected from many points on the subject. A camera lens redirects these reflected rays into corresponding points on the film. Each of these points is reproduced by the lens as a circle. When the circle is smaller than l/100 inch, it appears as a sharp point to the eye. When the circle is larger than 1/100 inch, the eye sees it as a circle, and the image is blurred or out of focus. Each out-of-focus circle on the film is called a *circle of confusion* and can be visualized as the cross section of a cone of a light ray (fig. 1-27).

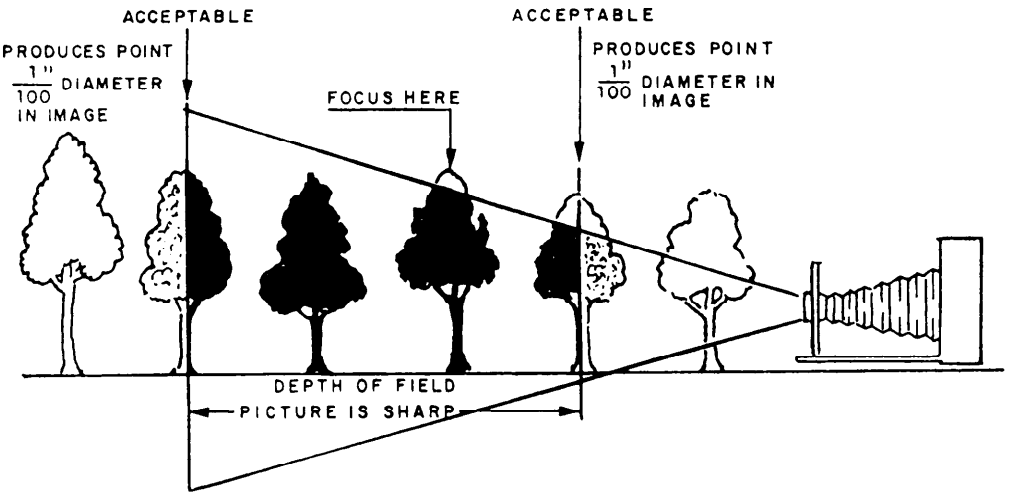


Figure 1-28.–Depth of field.

When a lens is focused on an object at a certain distance, other objects, both closer and farther than the focus distance, form larger circles of confusion. When the film is placed at a point corresponding to the lens focus distance, a clear image is produced (fig. 1-28). When the film is nearer or farther away from the lens than the corresponding lens focus distance, the image becomes blurred because of the larger circles of confusion caused by the intersection of light rays either in front of, or behind, the film plane.

Another factor affecting the circle of confusion is lens aperture. Decreasing a lens opening narrows the light rays passed by the lens. The narrower these rays, the smaller the circles of confusion when the image is not in perfect focus. In practice, this means that a small lens opening is used to record, as clearly as possible, several objects at varying distances. Even when the rays from some objects do not intersect perfectly at the film plane, the circles of confusion ahead or behind the film are negligible and still appear as a sharp image.

The size of the permissible circle of confusion depends on the film format size and the manner in which the film will be used. Experience has shown that the permissible circle of confusion should not exceed about 1/1000 of the focal length of the lens. This is normal for the film size. The generally accepted permissible circle of confusion diameters are given in table 1-3.

Table 1-3.–Permissible Circle of Confusion Is Dependent on Film Size

Film Size	Diameter (inches)
16mm	0.0010
35mm	0.002
2 1/4 x 2 3/4"	0.004
4 x 5"	0.006
8 x 10"	0.012

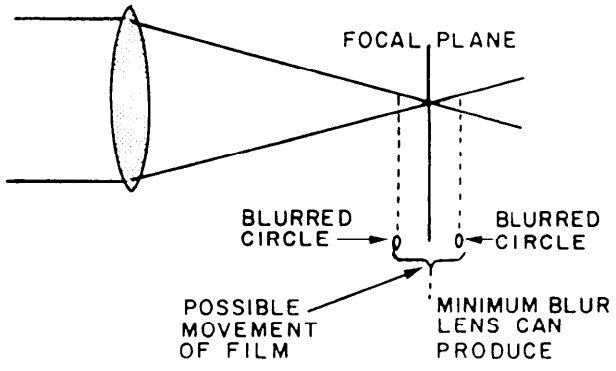


Figure 1-29.–Depth of focus.

The minimum circle of confusion of most lenses is small. Thus the focal plane can be moved slightly and yet retain an acceptable sharp image. However, as the distance of the movement is increased, the circle of confusion becomes greater and the image becomes less sharp. Consequently, the distance that the focal plane can be moved forward or backward from the plane of sharp focus and continue to produce an image of acceptable sharpness is termed the *depth of focus.* This depth is always within the camera (fig. 1-29).

HYPERFOCAL DISTANCE.–The hyperfocal distance of a lens is the distance from the optical center of the lens to the nearest point in acceptably sharp focus when the lens, at a given f/stop, is focused at infinity. In other words, when a lens is focused at infinity, the distance from the lens beyond which all objects are rendered in acceptably sharp focus is the hyperfocal distance. For example, when a 155mm lens is set at f/2.8 and focused at infinity, objects from 572 feet to infinity are in acceptably sharp focus. The hyperfocal distance therefore is 572 feet.

The following equation is used to find hyperfocal distance:

$$H = \frac{F^2}{f \times C}$$

Where:

H = hyperfocal distance

F = focal length of lens

f = f/stop setting

C = diameter of circle of confusion

F and C must be in the same units, inches, millimeters, and so forth.

NOTE: 1 inch is equal to 25.4mm.

Where:

F = 155mm (6.1 inches)

f = 2.8

C = 0.05 (0.002 inches)

Then:

$$H = \frac{6.1^2}{2.8 \times 0.002} = 6650 \textit{ inches} = 554 \textit{ feet}$$

Thus the hyperfocal distance for this lens set at f/2.8 is 554 feet.

Hyperfocal distance depends on the focal length of the lens, the f/stop being used, and the permissible circle of confusion. Hyperfocal distance is needed to use the maximum depth of field of a lens. To find the depth of field, you must first determine the hyperfocal distance. By focusing a lens at its hyperfocal distance, you cause the depth of field to be about one half of the hyperfocal distance to infinity.

DEPTH OF FIELD.–Depth of field is the distance from the nearest point of acceptably sharp focus to the farthest point of acceptably sharp focus of a scene being photographed Because most subjects exist in more than one plane and have depth, it is important in photography to have an area in which more than just a narrow, vertical plane appears sharp. Depth of field depends on the focal length of a lens, the lens f/top, the distance at which the lens is focused, and the size of the circle of confusion.

Depth of field is greater with a short-focal-length lens than with a long-focal-length lens. It increases as the lens opening or aperture is decreased. When a lens is focused on a short distance, the depth of field is also short. When the distance is increased, the depth of field increases. For this reason, it is important to focus more accurately for pictures of nearby objects than for distance objects. Accurate focus is also essential when using a large lens opening. When enlargements are made from a negative, focusing must be extremely accurate because any unsharpness in the negative is greatly magnified.

When a lens is focused at infinity, the hyperfocal distance of that lens is defined as the near limit of the depth of field, while infinity is the far distance. When the lens is focused on the hyperfocal distance, the depth of field is from about one half of that distance to infinity.

Many photographers actually waste depth of field without even realizing it. When you want MAXIMUM depth of field in your pictures, focus your lens on the hyperfocal distance for the f/stop being used, NOT on your subject which of course would be farther away than the hyperfocal distance. When this is done, depth of field runs from about one half of the hyperfocal distance to infinity.

There are many times when you want to know how much depth of field can be obtained with a given f/stop. The image in the camera viewing system may be too dim to see when the lens is stopped down. Under these conditions, some method other than sight must be used to determine depth of field. Depth of field can be worked out mathematically.

The distance, as measured from the lens, to the nearest point that is acceptably sharp (the near distance) is as follows:

$$ND = \frac{H \times D}{H + D}$$

The distance, as measured from the lens, to the farthest point that is acceptably sharp (the far distance) is as follows:

$$FD = \frac{H \times D}{H - D}$$

ND = near distance

H = hyperfocal distance

D = distance focused upon

F D = far distance

EXAMPLE: What is the depth of field of a 155mm (6.1 inch) lens that is focused on an object 10 feet from the camera lens using f/2.8? (Note: In a previous example the hyperfocal distance for the lens was found to be 554 feet.) By the formula, the nearest sharp point is determined as follows:

$$ND = \frac{H \times D}{H + D}$$

$$ND = \frac{554 \times 10}{554 + 10} = \frac{5540}{564} = 9.8$$

$$ND = 9.8 \textit{ feet}$$

Thus the nearest point in sharp focus is 9.8 feet from the lens that is focused on an object at 10 feet, using f/2.8.

Also by the formula, the farthest point in sharp focus can be determined as follows:

$$FD = \frac{H \times D}{H - D}$$

$$FD = \frac{554 \times 10}{554 - 10} = \frac{5540}{544} = 10.2$$

$$FD = 10.2 \textit{ feet}$$

Therefore, the far point in sharp focus is 10.2 feet when focused on an object at 10 feet, using f/2.8. Consequently, the depth of field in this problem equals the near distance subtracted from the far distance (10.2 - 9.8 = 0.4-foot depth of field). Thus all objects between 9.8 and 10.2 feet are in acceptably sharp focus. When this depth of field is not great enough to cover the subject, select a smaller f/stop, find the new hyperfocal distance, and apply the formula again.

When the only way you have to focus is by measurement, the problem then becomes one of what focus distance to set the lens at so depth of field is placed most effectively. There is a formula to use to solve this problem.

$$P = \frac{D \times d \times 2}{D + d}$$

Where:

D = distance to farthest point desired in sharp focus

d = distance to nearest point desired in sharp focus

p= distance to point at which the lens should be focused

Substituting the figures from the previous examples,

D= 10.2 feet

d = 9.8 feet

P= lens focus distance

Then:

$$P = \frac{10.2 \times 9.8 \times 2}{10.2 + 9.8} = \frac{200}{20} = 10 \textit{ feet}$$

$$P = 10 \textit{ feet}$$

To obtain the desired depth of field at f/2.8, we set the lens focus distance at 10 feet.

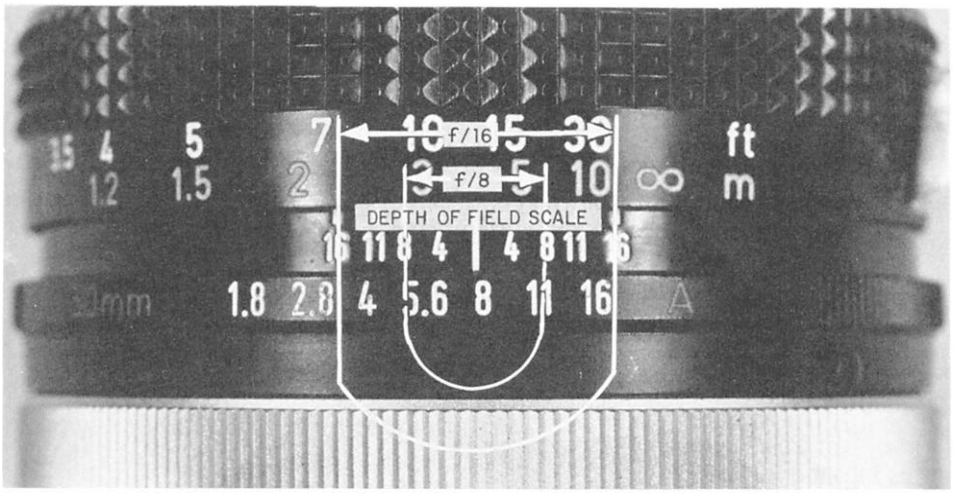
If the preceding explanations and formulas have confused you, here is some good news! Most cameras and lenses have depth of field indicators that show the approximate depth of field at various distances and lens apertures. Figure 1-30 shows that with the lens set at f/8 and focused at about 12 feet, subjects from about 9 feet to about 20 feet are in acceptably sharp focus. By bringing the distance focused upon to a position opposite the index mark, you can read the depth of field for various lens openings.

Keep in mind that a depth of field scale, either on the camera or on the lens, is for a given lens or lens focal length only. There is no universal depth-of-field scale that works for all lenses.

In conclusion, the two formulas used to compute depth of field serve for all distances less than infinity. When the lens is focused on infinity, the hyperfocal distance is the nearest point in sharp focus, and there is no limit for the far point.

CONJUGATE FOCI

Object points and their corresponding image points formed by a lens are termed *conjugate focal points.* The distances from the optical center of the lens to these points, when the image is in focus, are termed *conjugate focal distances* or *conjugate foci* (fig. 1-31).



302.15

Figure 1-30.–Depth of field on camera focusing ring.

The terms *object focal distance* and *image focal distance* are often used for these conjugate distances. It is obvious from these two terms that the object distance is outside the camera and the image distance is inside the camera. Since the focal length denotes only the distance from its center to the image when focused at infinity, we need some way to account for the fact that when we focus on closer objects the image focal distance can be much more than the lens focal length, with a corresponding effect on image size, effective aperture, and other factors.

The various ratios between image and object focal distances may be determined by a formula that contains the focal length of the lens and the ratio (scale) between the image size and the object size.

That is:

F = the focal length of the lens

R = the ratio between the image and object size or the ratio between the conjugate foci of the image and object

When R is determined by the following formula:

$$R = \frac{Image\ size}{Object\ size}$$

Object focal distance = F + F ÷ R)

Image focal distance = F + (F x R)

For a 1: 1 reproduction using a 50mm lens, your object focal distance is as follows:

$$50mm + \frac{(50mm)}{1} = 100mm$$

and the image focal distance is as follows:

$$50mm + (50mm \times 1) = 100mm$$

When the image formed by a lens is smaller than the object, the larger conjugate is outside the camera. When the image formed is larger than the object, the larger conjugate is inside the camera.

These conjugate focal distances have some interesting relationships that may be used in several ways. The following examples illustrate the practical value of these distance relationships:

EXAMPLE 1: A4x5-inch copy negative must be made of a 16x20 print using a camera equipped with a 10-inch focal length lens.

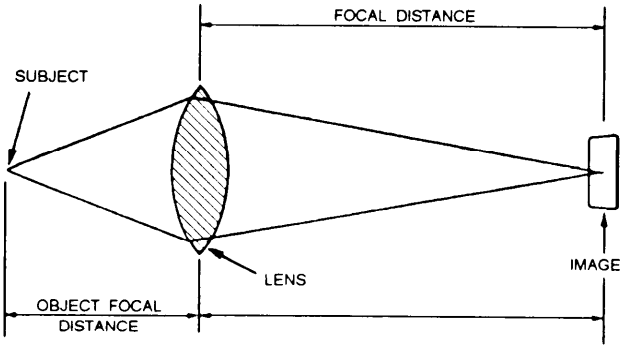


Figure 1-31 .–Conjugate distances.

PROBLEM: Determine the distance that is required between the film and the lens (the image focal distance) and the necessary distance between the lens and the print (the object focal distance).

The ratio between the film size and the print size (4:16 or 5:20) may be reduced by using the following formula:

$$R = \frac{4}{16} = \frac{1}{4}$$

Likewise:

$$R = \frac{5}{20} = \frac{1}{4}$$

Substituting the figures into the formula:

Object focal distance = F + (F ÷ R)

= 10+(10+ 1/4)

= 50 inches

Image focal distance = F + (F x R)

= 10 + (10 x 1/4)

= 12.5 inches

Therefore, the camera lens must be 50 inches from the print and the film must be 12.5 inches from the lens to make a 4x5-inch image of a 16x20 print using a 10-inch lens.

EXAMPLE 2: Make a full-length portrait of a man 6 feet (72 inches) tall using a 10-inch focal-length lens, and make the image on the film 5 inches long.

PROBLEM: How much studio space is required to make this photograph?

The ratio is 5:72, which reduces to

$$R = \frac{5}{72} = \frac{1}{14.4}$$

Substituting the formula:

Image focal distance = $10 + (10 \times \frac{1}{14.4}) = 10.7$ *inches*

Object focal distance = $10 + (10 + \frac{1}{14.4}) = 154$ *inches*

Adding 10.7 inches and 154 inches and converting to feet gives a film to subject distance of 13.7 feet. However, there must be enough space added to this distance to allow a background behind the subject and operating space behind the camera. Three or four feet at each end is about the minimum for good work Thus, if the room is not at least 20 feet long (13.7 + 6 = 19.7), a portrait this size cannot be made with a 10-inch lens.

EXAMPLE 3: A diagram 4 inches square is to be photographed so the image on the film is 8 inches square. Using a 10-inch lens, how much bellows extension, or camera length, is required? The ratio here is 8:4, or

$$R = \frac{8}{4} = 2$$

The image focal distance equals the bellows extension or the required length of the camera.

Substituting:

Image focal distance = 10 + (10 x 2)

= 30 inches

If the camera does not have sufficient bellows extension to allow the film to be placed 30 inches from the lens, the required negative or image size cannot be made with this camera and lens.

It is not difficult to calculate the various distances for different jobs. The photographer also saves the time and unnecessary work usually required by the trial-and-error method.

Image/Object Relationship

The size of the image formed by a lens is dependent upon the following:

- The size of the subject
- The lens-to-subject distance
- The lens focal length

The size of the image of any object at a given distance is directly proportional to the focal length of the lens being used. That is, when a given object at a given distance appears 1 inch high on the focal plane when a 3-inch lens is used, it appears 2 inches high when a 6-inch lens is used and l/2 inch high when a 1 1/2-inch lens is used.

The proportion illustrated in the following figure is the basis of the equation commonly used for solving image-object and focal length distance relationship problems (fig. 1-32).

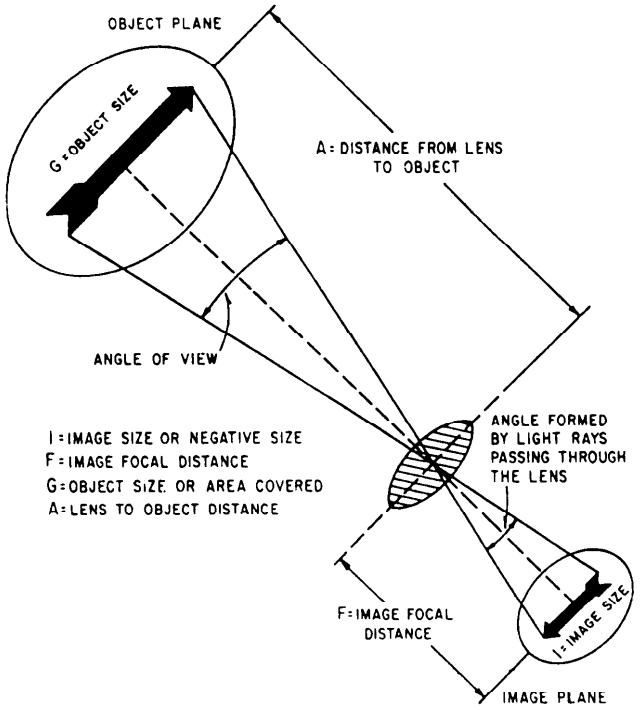


Figure 1-32.–Proportional IFGA.

All image-object and focal length distance relationship problems can be computed with the following simple proportion:

The image size (I)

is to the image focal distance (F)

as the object size (G)

is to the object focal distance (A)

You should thoroughly understand this equation since you will have many uses for it in many different applications of photography.

Study the proportional IFGA figure and note the following:

I - the image size

F - the image focal distance

G - the object size

A - the distance from lens to object

The ratio of image size to image focal distance is the same as the ratio of object size to object focal distance as follows:

I:F = G:A

The mathematical equation resulting from this proportion is as follows:

IA=FG

The proportion may be written in fractional form as follows:

$$\frac{I}{F} = \frac{G}{A}$$

When solving for I:

$$I = \frac{FG}{A}$$

When solving for A:

$$A = \frac{FG}{I}$$

To clear or set apart one factor of an equation so it may be solved, divide the equation by all factors on that side of the equation except the one to be set apart.

When solving for F:

$$F = \frac{IA}{G}$$

When solving for G:

$$G = \frac{IA}{F}$$

These four formulas are from the same equation IA = FG.

Inches and feet are used in the equation that eliminates the computations required to reduce feet measurements to inches. However, the relation of inches to inches and feet to feet must be maintained on the respective sides of each equation Keep I and F values in inches and G and A values in feet. Then, when solving for I or F, the result will be in inches. When solving for G or A, the result will be in feet.

In the sample problems which follow, the IA = FG formula is used as though the camera were focused at infinity.

PROBLEM 1: A lens with a focal length of 12 inches is used to photograph an object 10 feet high from a distance of 30 feet. What is the size of the image? Solve for the unknown factor (image size) by substituting the known factors (focal length, object size, and distance) into the equation IA = FG. The formula and computations are as follows:

$$I = \frac{FG}{A}$$

$$I = \frac{12 \text{ x } 10}{3\,0}$$

I = 4, or image size equals 4 inches

This computation can be done with lenses marked in millimeters; however, the result will also be in millimeters. At this point, you must convert millimeters to inches as follows:

$$I = \frac{305mm \text{ x } 10\ ft}{30}$$

$$= 101mm \text{ x } .04\ (conversion\ factor) = 4\ inches$$

Where:

I = the image size

F = the focal length

G = the object size

A = the distance from the lens to the object

PROBLEM 2: A 24-inch focal-length lens is used to photograph an object 10 feet high from a distance of 30 feet. What is the length of the image? The formula and computations are as follows:

I = 8 inches

or, solving to prove the unit of measure of the result.

$$I = \frac{FG}{A}$$

$$I = \frac{24 \text{ x } 10}{30}$$

$$I = \frac{24\ inches \text{ x } 10\ feet}{30\ feet}$$

I = 8 inches or image size

I = 8 inches

As an example of a typical situation whereby you can make use of the IA = FG formula, suppose you are requested to make a 9-inch photograph of a board 12 feet long. This board is mounted on a wall and the maximum distance from that wall to the opposite side of the room is 20 feet. Is it possible to make this photograph using an 8x10 camera equipped with a 12-inch focal-length lens?

The known values are object size (12-foot board), requested image size (9 inches), and the focal length (12 inches). The unknown factor is the necessary lens-to-subject distance required to make the photograph using this camera. The formula and computations are as follows:

IA = FG

$$A = \frac{FG}{I}$$

$$A = \frac{12\ inches \text{ x } 12\ feet}{9\ inches}$$

A= 16 feet

The required lens-to-subject distance equals 16 feet. The answer to this problem then would be yes, since the required lens-to-subject distance is only 16 feet. This allows the photographer 4 feet (20 - 16 = 4) in which to set up and operate the camera.

PROBLEM 3: An image 4 inches long of an object 8 feet high at a distance of 20 feet is focused on the film plane. What is the lens focal length?

IA = FG

$$F = \frac{IA}{G}$$

$$F = \frac{4 \text{ x } 20}{8}$$

F = 10, or focal length equals 10 inches

Another problem to illustrate the application of the proportion I:F=G:A follows: When using an 8x10 camera equipped with a 12-inch focal-length lens to obtain a 9-inch image from a distance of 16 feet, you can photograph an object of what maximum length? To solve this problem, you should have the formula and computation as follows:

$$G = \frac{IA}{F}$$

$$G = \frac{9\ inches \text{ x } 16\ feet}{12\ inches}$$

G = 12 feet

The maximum length of an object that can be photographed with this 12-inch lens, using an image size of 9 inches from a distance of 16 feet, is 12 feet.

Using Various Lenses

It is possible for you to take all your pictures with only one lens. But before long, you will want to expand your range of lenses to become a more versatile photographer.

Within our Navy, 35mm single-lens reflex (SLR) cameras are coming into ever-increasing use. Every Navy photo unit should have several SLR cameras, and

by and large, they are the cameras most used. For these reasons we shall limit our discussion of using different lenses to 35mm SLR cameras. Keep in mind, however, that the *concepts* discussed apply equally well to all cameras and lenses no matter what their size of focal length may be.

Lens interchangeability is one of the great features of SLR cameras. SLR cameras have focal-plane shutters directly in front of the film so the lens can be removed and replaced at any time without fogging the film. Most makes of lenses and cameras are designed with their own exclusive method of lens attachment. Some use screw-in lenses; others use bayonet mounts. And each lens is either incompatible with or requires special adapters to fit other brands.

Lenses for 35mm cameras are generally divided into two groups. The first group is a basic set of three. These are moderately wide angle, normal, and moderately long focal length. The second group is a variety of special lenses. This group of special lenses includes ultra-wide angle, extreme telephoto, shift lenses, variable focal length (ZOOM), and macro lenses.

Most experienced Navy photographers who use a 35mm camera agree that a basic set of lenses is well worth having. Their choice of actual focal-length lenses is a far more personal decision. One may prefer a 35mm wide angle and a 200mm long focal length. Another photographer may prefer a 28mm wide angle and a 135mm long-focal-length lens.

There are two occasions for changing lenses. The first is when your viewpoint or camera position cannot be changed. Imagine that you are aboard a ship and taking pictures of the coastline. To get a broader view of the coastline, you cannot move your camera position because the ship is on course. The solution is to change to a wide-angle lens. To get a closeup shot of an important section of the coastline, you obviously cannot move closer to the shore. You must change to a long-focal-length lens to bring the important section of coastline closer to you. The second time you would change lenses is when a different focal-length lens enhances your subject (remember the cow having lunch). This depends on your ability to change camera viewpoint, forward and backward, so you can fill the picture area with the subject. Using a long-focal-length lens reduces depth of field, makes the apparent effect of linear perspective less dramatic, and decreases the *apparent* distance between different subject planes.

The use of a wide-angle lens has the opposite effect. It increases depth of field, exaggerates apparent linear perspective, increases the apparent distance between subject planes, and may introduce image distortion.

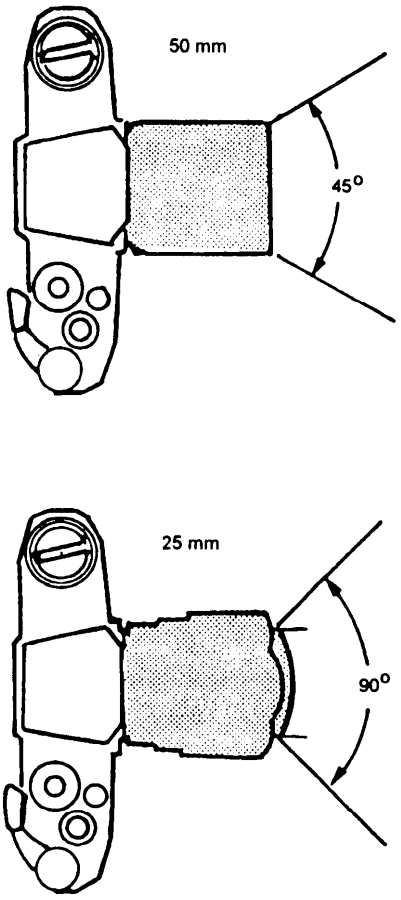


Figure 1-33.–Comparison of angle of view on camera lenses.

As the focal length increases, the image gets bigger and the angle of view becomes smaller. You cannot change the picture area produced on film by a 35mm SLR camera. The picture area is always 24mm by 36mm. Lenses for 35mm SLRs (except some ultra-wide lenses) all produce an image that completely fills the picture area. Along lens magnifies the subject image and not as much of it fits into the film frame area (fig. 1-33). Thus long-focal-length lenses cut down the area you see around the subject, and they, therefore, have a small *angle of view.*

Short-focal-length lenses produce much smaller images from the same camera position than long lenses. The small image of a subject looks farther away and much more area surrounding it can be included in the picture area. A short-focal-length lens gives a wide-angle view. This is why short-focal-length lenses are called wide-angle lenses.

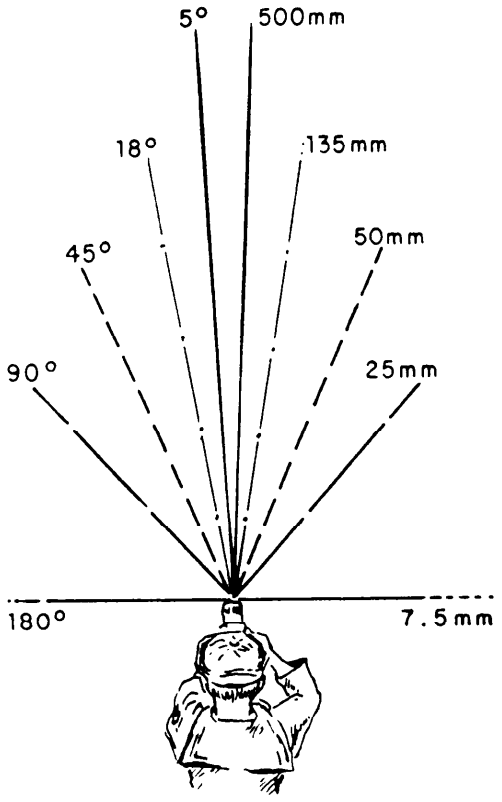


Figure 1-34.–Angle of view.

In figure 1-34, the diagram shows the different angles of view you can expect from several common focal-length lenses used with 35mm SLR cameras.

Table 1-4 can be used in selecting lenses for one film format that provides the same angle of view produced by another film format and the lens focal-length combinations.

To use this table, select the lens for one film format that provides the same angle of view produced by another film format and focal-length combination. Example: The angle of view of a 360mm lens on a 4x5 camera is 19 degrees. To match the angle of view approximately with a 35mm camera, a 105mm lens is needed. The normal focal-length lens (50mm) for a 35mm camera provides an angle of view of 40 degrees (width). You can see from the table that the normal focal-length lens for a medium format camera (2 1/4" x 2 1/4") is an 80mm lens because it provides approximately the same angle of view (38 degrees).

TYPES OF LENSES

There is a large variety of lenses available for most hand-held cameras on the market today. These lenses are used for different photographic applications. The types of lenses you may use in the fleet are as follows: wide angle, ultra-wide angle, rectilinear, macro, normal focal length, telephoto, and variable focal-length, or zoom, lenses.

Wide-Angle Lenses

Anything less than 40mm in focal length (for a 35mm camera) is considered a wide-angle lens. Again, we are speaking of the lens focal length as it applies to 35 mm cameras.

A wide-angle (short focal length) lens is designed to take in a large view and is indispensable when working in confined spaces or when you want to cover a large area. Wide-angle lenses have their own qualities, causing *apparent,* repeat, *apparent,* distortion and foreshortening of perspective, so objects close to the lens *appear* large, while background objects diminish in size dramatically.

Many photographers choose a 28mm lens for their 35mm camera wide-angle lens. This is partly because this focal length allows the typical wide-angle effects without introducing apparently distorted images, such as *bent walls.* As well as providing a wider field of view, wide-angle lenses also produce great depth of field at all apertures.

Short-focal-length lenses do not, as is often believed, actually change perspective. The close viewpoints allowed by wide-angle lenses can cause perspective effects that *appear* distorted but are perfectly natural ways of seeing objects at close range.

A wide-angle lens magnifies features nearest the camera To fill the frame when photographing people with a wide-angle lens, you must move in close. This causes a distorted view. But wide-angle lenses can be used when special effects are desired, such as deliberate distortion, when exaggeration of features or when surrounding areas add to the viewer's understanding of the subject.

A lens hood, or lens shade, is an important accessory for any lens. It is especially important with a wide-angle lens. Strong light can easily cause flare when reflected internally between the elements of the lens, and unless you take proper precautions by using a lens hood, your pictures may be spoiled. Sometimes you are able to see flare or ghosting in the viewfinder, but more often than not, it is not visible to the human eye, and it only shows up on the processed film.

Another precaution to take with wide-angle lenses concerns filters and other accessories attached to the

Table 1-4.-Choosing Lenses to Match Angle of View

Film Format	Focal Length Lens (mm)	Angle of View, Long Film Dimension (degrees)	Angle of View, Short Film Dimension (degrees)
16mm	10	52	41
	17	32	25
	25	22	17
	50	11	8.5
	75	7.5	5.6
35mm	15	100	77
	20	84	62
	24	74	53
	28	65	46
	35	54	38
	50	40	27
	90	23	15
	105	19	13
	135	15	10
	200	10	6.9
	300	6.9	4.6
2 1/4” x 2 1/4”	30	85	85
	0	69	69
	50	58	58
	80	38	38
	120	26	26
	150	21	21
	250	13	13
	350	9	9
4” x 5”	65	85	72
	75	77	65
	90	67	56
	150	44	35
	210	32	25
	300	23	18
	360	19	15
8” x 10”	165	73	61
	210	61	50
	300	45	36
	360	38	30
	420	33	26

front of the lens. When you use more than one filter or a particularly thick filter, you may end up with vignetting. This results in the edges of the image being cut off, particularly at wide apertures. When using wide-angle lenses, you should use lens hoods and filters designed for the particular lens in question.

Ultra-Wide-Angle Lenses

Many ultra-wide-angle, or short-focal-length, lenses are known as *fisheye* lenses. These lenses have a focal length of less than about 17mm (for a 35mm camera). The ultra-wide-angle view of these lenses results in image distortion. Straight lines appear curved and curved Lines may appear straight.

The use of fisheye lenses makes objects appear to diminish in size rapidly as the distance from the camera increases and objects which are close to the camera appear far apart.

Depth of field with a fisheye lens is very great. 'They often give depth of field that extends from only inches in front of the lens to infinity so that focusing is not necessary.

Rectilinear Lenses

A rectilinear lens, despite its wide angle, has normal rectilinear corrections so straight subject lines are straight in the image and there is no obvious distortion. The width of objects close to the camera appears emphasized because of the steep perspective produced by a rectilinear lens.

Macro Lenses

A macro lens is used for closeup photography and is a valuable lens for any imaging facility to have. These lenses come in various focal lengths and are capable of producing up to one half or even life-size 1:1 images. For example, a 100mm macro lens produces a 1:1 image just as a 50mm macro does. With a 100mm lens, you do not have to get as close to the subject. This is especially useful when you are taking pictures of live creatures or doing closeup medical photography.

Normal Focal-Length Lenses

The standard or normal focal-length lens for a 35mm SLR camera is from about 40mm to 58mm (the most common being 50mm). This focal length gives a field of view roughly the same as that over which the eye gives satisfactory sharpness-thus the name *normal*

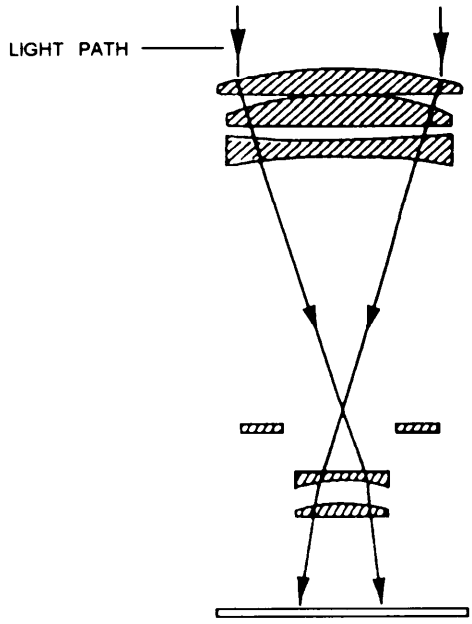


Figure 1-35.–Arrangement of lens elements in a telephoto lens.

focal length. With a normal lens, the angle of view and the image size you see in the viewfinder are normal. That is, you get much the same impression as you would get if you look at the subject with one eye. Many Navy photographers claim, however, that the wider angle of view of a 35mm lens (for a 35mm camera) is preferable. Others maintain that an 85mm focal length is better for general use because it enables the picture space to be filled more easily with subject matter.

A normal lens can be used for making pictures of people if you do not get too close. When you fill the frame with the face of the subject, you get image distortion. It is better to stand farther back and include the shoulders of the subject in the picture. This eliminates distortion.

Telephoto Lenses

A lens with a focal length greater than about 58mm for a 35mm camera is a long-focal-length lens. Most modern, long-focal-length lenses are called *telephoto* lenses because of their compact design. At one time, long-focal-length lenses were essentially a lens at the end of a long tube. A 500mm lens was spaced 500mm from the film, and so on. However, by incorporating other glass elements, the light passing through the lens can be modified (fig. 1-35). This permits the lens barrel to be physically shorter than the lens actual focal length-an arrangement known as telephoto.

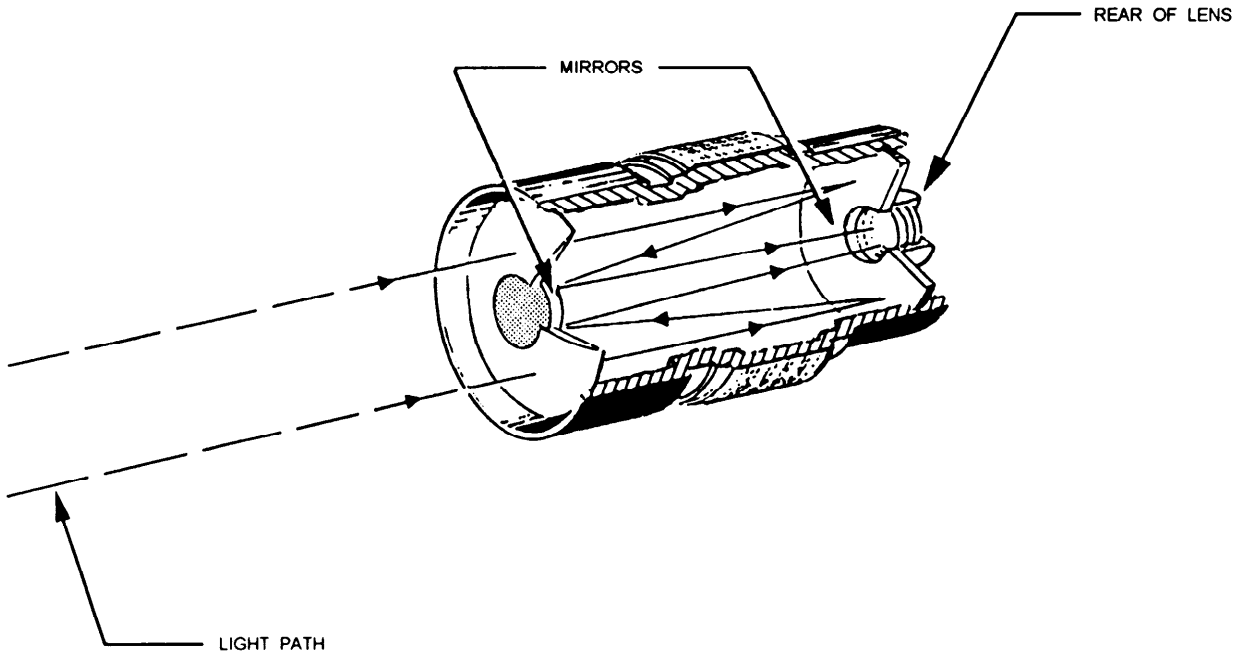


Figure 1-36.–Reflecting telephoto lens.

The overall physical length of a telephoto lens is usually only about one half of its focal length. A basic, long-focal-length lens must be placed one focal length away from the film if it is to form an image of a subject at infinity. In the case of a telephoto (or mirror) lens, the lens-to-film distance is reduced considerably while still retaining the effects of a long-focal-length lens. Thus a 1000mm telephoto lens rear element may only be 500mm away from the film when the lens is set at infinity.

Those 35mm camera lenses that range from about 85mm to 135mm are good for shooting pictures of people. They allow you to shoot from about 6 feet away and still fill the frame with the subject's face. Six feet from the subject is a good working distance. It is not too close for comfort, and it is not so far away that intimacy is lost.

Telephoto compression is the apparent compression of perspective. A telephoto lens does not compress perspective; it only appears that way! Remember, perspective does not depend on the lens being used, but on the position of the camera.

So then, how does a telephoto lens produce the effect of compressed perspective? Several factors are involved:

- A telephoto lens is used from farther away to obtain the same size image that would be produced by a shorter lens at a closer distance. The more distant camera position produces a flatter perspective. But, because the long lens magnifies the subject, it still produces a normal size image. Thus the looks are flatter than expected.

- The distance from which the print is viewed also has an effect. An X-times enlargement should be viewed from X-times the focal length of the lens used to make the picture in order for the perspective to appear natural. Therefore, a 6X enlargement of a negative shot with a 50mm lens should be viewed from 6X 50mm = 300mm or 12 inches, while a picture made with a 500mm telephoto lens and enlarged 12 times should be viewed from20feet(12 x 500mm=600 x 0.04 = 240 ÷ 12 = 20 feet). (Note: To convert millimeters to inches, multiply the known millimeters by 0.04.)

A reflecting telephoto lens, the so-called mirror lens, has *folded up* optics. It uses internal mirrors to reflect the light twice. This enables the lens barrel to be much shorter, but because of the mirrors, it must also be much broader. As shown in figure 1-36, light that enters the lens through a glass plate is converged and reflected back by a concave mirror at the back of the lens. This reflected light is directed to a small backward-facing



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Figure 1-37.–Out-of-focus highlights caused by a mirror lens.

mirror lens element at the center of the front glass plate. In turn, the mirror lens reflects the light back through a hole in the concave mirror to a focus on the film.

Mirror lenses have the advantage of long focal length, relatively short physical size, and large aperture. But they also have disadvantages, the main one being that a diaphragm cannot be used and the lens must always be used at maximum aperture. Therefore, exposure must be controlled by the shutter alone or by the use of neutral density filters, or both. Because of this aperture disadvantage, mirror lenses have limited depth of field. Another disadvantage is that out-of-focus highlights record as rings of light (fig. 1-37).

Variable Focal-Length Lenses

A variable focal length, or *zoom,* lens is designed so the focal length can be changed by mechanically moving the elements within the lens. The movement of lens elements, in unison and in precise order, gives a smooth change of image size while maintaining acceptably sharp focus throughout the entire adjustment. The simplified drawing of a zoom lens (fig. 1-38) illustrates how the movement of elements within the lens can change the focal length while maintaining correct lens-to-film distance.

While only the shortest and longest focal lengths for this particular lens are shown in the drawing, various other focal lengths are possible.

The biggest advantage of a zoom lens is that you have many focal lengths in one single lens. You do not have to change lenses to use a different focal length. Sometimes it is impossible to change your viewpoint to improve a picture. But with a zoom lens you can *zoom* in and out (change focal length) until you get the exact image you want. One disadvantage is the extra bulk and weight of the zoom lenses. There is also some loss in picture quality when compared to the performance of a fixed focal length lens. There are four basic types of wide to telephoto zoom lenses for 35mm cameras:

- *Wide-range* zoom lenses have focal lengths from about 28mm to 80mm. They often take the place of fixed focal-length lenses of 28mm, 35mm, 50mm, and 80mm.

- *Mid-range* zoom lenses have focal length that do not extend very far on either side of a normal lens focal length. Mid-range zooms for 35mm cameras have a

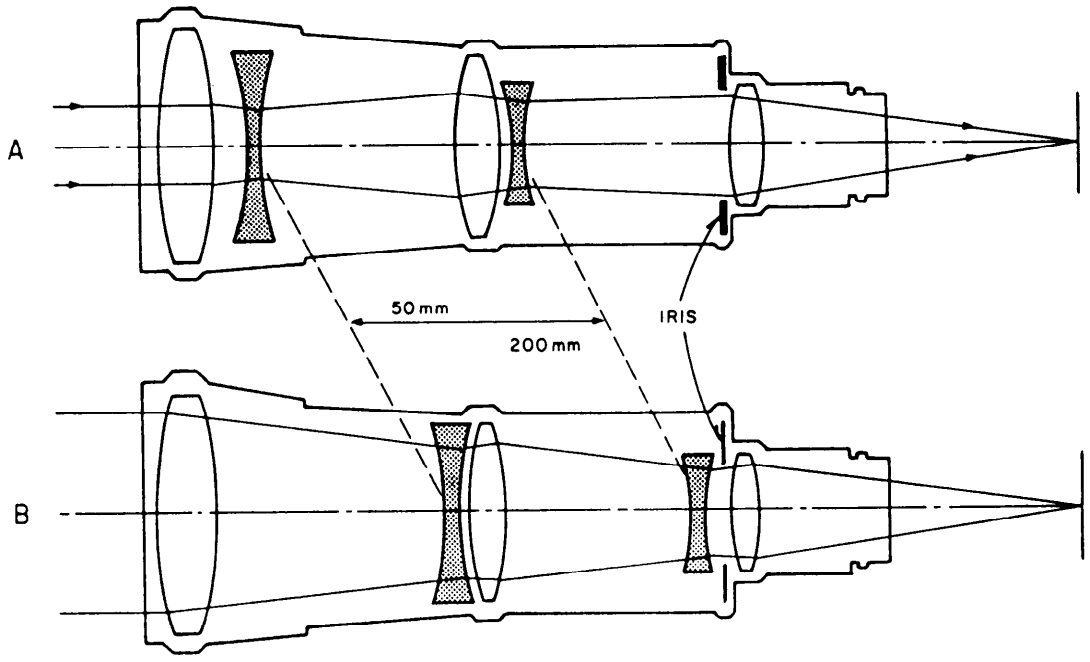


Figure 1-38.–Variable focal-length (zoom) lens.

variable focal length from about 35mm to 70mm. They are usually small and lightweight. They are designed to be used instead of a normal focal-length lens, not to replace a range of focal length lenses.

- *Long-range* zoom lenses start at about 35mm and include the popular 100mm or 105mm focal lengths. They can take the place of four, fixed focal-length lenses: the 35mm, 50mm, 85mm, and 105mm.

- *Telephoto-range zoom* lenses have focal lengths that range from about 50mm to 135mm, 90mm to 23Omm, 75mm to 150mm, and even 135mm to 600mm. The most popular telephoto zoom is from about 80mm to 200mm.

Now you have some basic knowledge of the way light reacts when striking various objects. You also know how it forms an image through a lens. With practice, you will be able to apply these principles in photographic practices. By using various focal-length lenses and aperture settings, you can control image size and depth of field as well as the apparent perspective of your photographs. In the next chapter, light-sensitive materials are discussed. This will enable you to record permanent images.

CHAPTER 2

LIGHT-SENSITIVE MATERIALS

Many substances are affected in some way by light. The light-sensitive substances used in photographic film to record an image are silver salts and are called **silver halides.** The silver halides react to ultraviolet radiation, violet, and blue light only; however, they can be made sensitive to other colors of light and infrared radiation by the addition of dyes. Depending on the amount of light and the type of silver halide, the light produces a visible or invisible change in the halides of a film or printing paper. An invisible change is made visible by development.

Photographic films and papers are composed of two basic parts: the emulsion and the base, or support. The emulsion is the light-sensitive portion of a film or paper that records the image. The emulsion contains the silver halides and any special sensitizing dyes suspended in a binder of gelatin. The gelatin holds the silver halides evenly dispersed and prevents action by a developer until the silver halides have been made developable either by exposure to light or chemical action. Also, the gelatin acts as a sensitizer for the silver salts.

In photographic films and papers, the primary purpose of the base is to support or hold the emulsion in place. The base, or support, may be transparent or opaque, depending upon how the recorded image is to be used. A transparent base is used for transparencies that are viewed by transmitted light and for negatives that are printed with transmitted light. An opaque base is used for prints that are viewed by reflected light.

The latest state of the art in light-sensitive materials used in photography is the use of the electronic medium. Video disks do not contain an emulsion or a base. When electronic mediums are used, light is converted to electrical impulses and these impulses are stored magnetically on a tape or disk. Since it is the camera itself that converts light to electrical impulses, the recording medium and all stages of the photographic process can be carried out in normal room light.

BLACK-AND-WHITE FILM

The characteristics and use of black-and-white film depend largely on the actual construction of the emulsion. These characteristics include the following: the degree of sensitivity to light, response to various colors of light (color or spectral sensitivity), contrast, exposure latitude, emulsion latitude, and emulsion definition.

There are many types of black-and-white films available. Each type differs somewhat from the others. You should become acquainted with the characteristics of films. This knowledge is helpful in selecting the film most suitable for each photographic assignment.

EMULSION SENSITIVITY TO LIGHT

The silver halides and sensitizing dyes of most film emulsions are very sensitive to small amounts of light. This light causes invisible changes to the emulsion and is called the **latent image.** The latent image can be physically made visible by the chemical step of development. The extent of the reaction to the light of the emulsion is affected greatly by the size of the silver halide grains and the amount of light reaching the film. The inherent property of a film emulsion to respond to light is termed *film speed.*

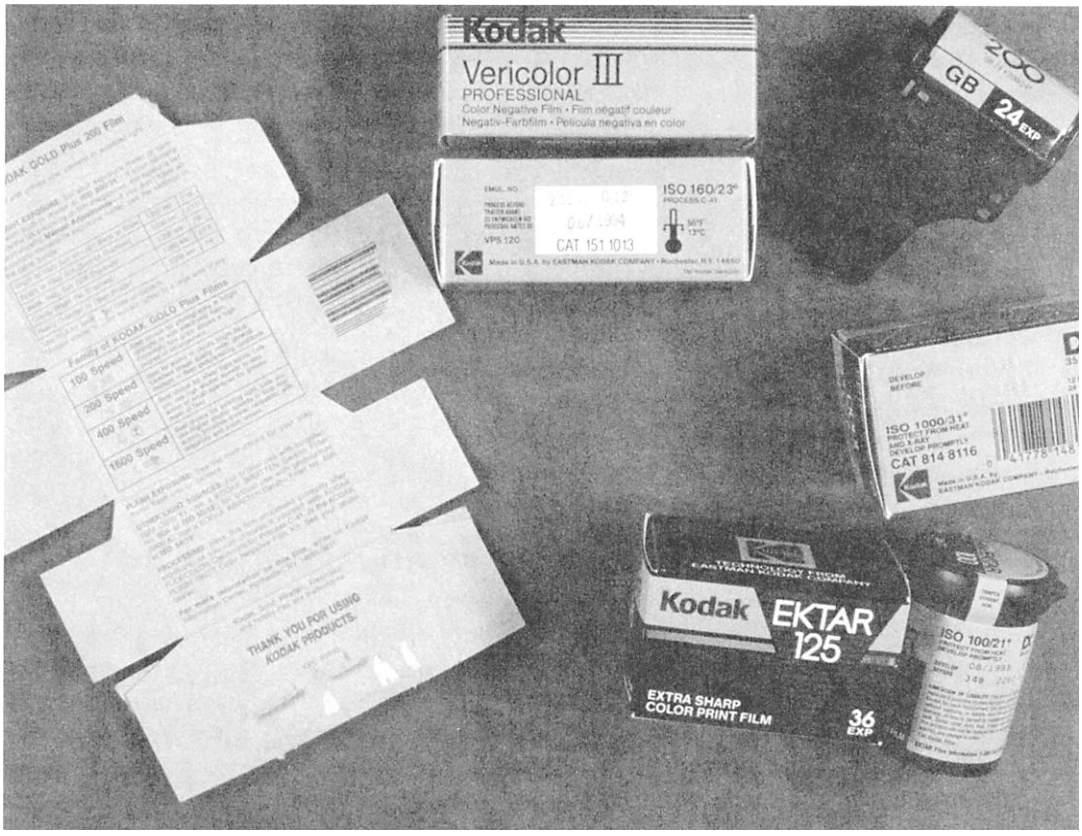
Film Speed

Film speed is important, since it is related to the amount of exposure required to produce an acceptable image. Emulsions are rated as slow, medium, or fast, depending on the amount of light required to produce an image satisfactorily. Fast emulsions require less light to produce an acceptable image than slow emulsions.

To calculate the exposure for a film emulsion accurately and consistently with a light meter, the manufacturer has developed a system of rating emulsion speed. The rating system used is the IS0 film speed system. ISO film speed is a numerical value assigned to an emulsion used for determining exposures.

The International Standards Organization (ISO) is a federation of all the national standard bodies of the world. It has approved a uniform set of film speed standards. The standards call for a universal expression of both arithmetic and logarithmic speed values with the ISO designation. The ISO designation generally looks like the following:

ISO 100/21°



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Figure 2-1.–IS0 of film.

The ISO assigned to a film is labeled on the packaging material and on the film cassette or paper backing (fig. 2-1). Some types of black-and-white films are assigned one ISO number; others are assigned two or more. Whether one or more film speeds are assigned depends on whether the film responds differently to different colors or color temperatures of light. Often, this results in a film having one speed for daylight and another for tungsten light. The ISO for a particular film is valid for calculating correct exposure only when that film is developed as recommended by the manufacturer.

An exposure index is another numerical value assigned to some films for exposure calculation. The exposure index is a more accurate method of film speed, because it is determined by processing a particular film through the actual process in an imaging facility. Exposure indexes are generally assigned to films used for copying or for technical applications.

SPECTRAL SENSITIVITY.–The response of an emulsion to specific colors of light or radiant energy is termed *coIor* or *spectral sensitivity.* You already know, from our earlier study of light in chapter 1, that the visible spectrum is made up of violet, blue, green, and red light. When speaking of film or emulsion sensitivity, you are also referring to its sensitivity to ultraviolet and infrared radiation. Spectral sensitivity of an emulsion simply means that the emulsion is sensitive to some energy of the electromagnetic spectrum. Also, emulsions have color sensitivity, which means they are sensitive to one or more colors of the visible spectrum. In this chapter, the terms *color sensitivity* and *color response* are used interchangeably. Color sensitivity or color response refer to ultraviolet and infrared radiation as well as visible light.

All silver halides are sensitive to ultraviolet radiation, violet, and blue light. *Color-blind emulsion* is the term given to emulsions sensitive only to these radiations. The addition of sensitizing dyes to silver halides can increase the sensitivity of emulsions and extend their sensitivity to green and red light and infrared radiation. Increasing the color sensitivity of an emulsion to other than ultraviolet, violet, and blue is called dye, color, or optical sensitization.

The color sensitivity of a black-and-white film is an important characteristic, since it controls the way colored objects record as tones of gray in the negative

or print. The color sensitivity determines how the film is classed. There are four general classes of black-and-white film emulsions. The four classes are as follows: colorblind (monochromatic), orthochromatic, panchromatic, and infrared. Some of these emulsions respond to a wide range of wavelengths of light. Others respond to only a narrow band of wavelengths. Light-sensitive emulsions are sensitive to all wavelengths of ultraviolet radiation. For all practical purposes, the general classes of emulsions are considered insensitive to the shorter wavelengths of ultraviolet (UV) radiation. This is because glass lenses and the gelatin in most film emulsions completely absorb the shorter wavelengths of ultraviolet radiation. When UV is to be used for photography, a special film with a thin emulsion is required.

Color-blind Emulsions.–Black-and-white color-blind emulsions are sensitive only to UV radiation, violet, and blue light. Green and red objects record only as clear areas in the black-and-white negative and reproduce as dark areas in the print. Color-blind films are used primarily for copying and graphic arts photography and may be assigned three or more ISO values; for example, ISO/50 for daylight, ISO/8 for tungsten light, ISO/20 for white-flame arcs, and ISO/12 for pulsed xenon.

Orthochromatic Emulsions.–Orthochromatic emulsions are sensitive to ultraviolet radiation, violet, blue, and green light. The sensitivity to green light is gained by the addition of a sensitizing dye to the color-blind silver halides. The emulsions provide an approximate correct reproduction of blue and green objects as corresponding tones of gray in a print; however, red objects record as clear areas in the negative and black areas in the print. since the emulsion is not sensitive to red. Various orthochromatic films with different degrees of contrast, color sensitivity, and emulsion speed are available. Their trade names usually contain the word *ortho*. Orthochromatic emulsions are used primarily for copying and graphic arts photography.

Orthochromatic emulsions that may be used in either daylight or tungsten light are assigned two separate ISO film speeds. This is because these emulsions are highly sensitive to the predominantly blue colored daylight and less sensitive to the tungsten light that has a higher content of red light.

Panchromatic Emulsions.–Panchromatic emulsions are sensitive to UV radiation, violet, blue, green, and red. The emulsion spectral sensitivity to green and red light is gained by adding sensitizing dyes to the color-blind silver halides. Panchromatic film of varying degrees of contrast, color sensitivity, and emulsion speed is available. Panchromatic emulsions are used for copying, portraiture, and general black-and-white photography.

Panchromatic emulsions are assigned only one IS0 film speed. This is because panchromatic emulsions are sensitive to red light and have an almost equal response to predominately blue-colored daylight and predominately red-colored tungsten light.

Infrared Emulsions.–Infrared (IR) emulsions are sensitive to UV radiation, violet, and blue light, with little or no sensitivity to yellow-green light but with additional sensitivity to red and IR radiation. The sensitivity to infrared radiation is gained by adding a sensitizing dye to the color-blind silver halides. Infrared emulsions are commonly used for aerial and medical photography as well as forensic photography (photography used for evidence). For best results a black-and-white UV film should be exposed only with IR radiation. To prevent any IR radiation or visible light from affecting the infrared emulsion during exposure, you must use a dark, red filter over the camera lens.

Since infrared radiation does not focus at the same point as visible light, a lens focus adjustment is necessary for critical focusing. Most lenses have a calibrated infrared focusing position on the focusing scale. This position is usually marked by a small, red dot or the letter *R* in red.

Determining a useful exposure index becomes a problem with infrared film, because exposure meters are calibrated for visible light and similar light sources can emit different amounts of infrared radiation. When using infrared film, you should make trial exposures for each particular film and photographic situation.

Contrast

In the development process, the silver halide grains in a black-and-white film exposed to light remain in the film. These grains form the image of the original scene. The colors of the scene are recorded in the negative as densities of gray instead of appearing as their original colors. These densities of gray can range from very dense to very thin. This depends upon the brightness of the objects in the scene, their color, and the color sensitivity of the film. The ratio of the maximum to the minimum brightness of objects in a scene is referred to as the scene brightness range. Most long scale black-and-white films are capable of recording scene brightness ranges up to 128:1. In a negative, a

light-colored object records as a heavy-density (dark) area, and a dark-colored object records as a low-density (thin) area; therefore, a negative image is reversed compared to the original scene. This reversal is produced by a bright object in the scene reflecting more light than a darker object. The greater amount of reflected light from the brighter object affects more silver halides in the emulsion.

The portions of the negative where the most silver halides have been affected are referred to as HIGHLIGHTS. The portions that are least affected are referred to as SHADOW AREAS. The light reflections from objects other than the brightest and darkest are referred to as MIDTONES.

The amount of metallic silver deposit in any portion of a negative is referred to as density. The amount of light that a negative transmits in a given period of time is controlled by the density of the metallic silver deposits. Therefore, density is used to describe the light-stopping ability of a negative.

The difference in densities between areas in a negative is known as **contrast.** The total contrast (density range) of a negative is defined as the difference in density between the least-dense shadow area and the most-dense highlight area in a negative.

Emulsion Latitude

The inherent ability of a black-and-white film to record a range of scene brightness differences as differences in density is termed *emulsion latitude* Normal- and low-contrast emulsions can record a wide range of scene brightness values and are considered to have a wide emulsion latitude or long scale. High-contrast emulsions record a short range of scene brightness values and are considered to have a narrow emulsion latitude or short scale.

Exposure Latitude

The amount the exposure can be varied (increased or decreased) from the ideal exposure and still provide an acceptable negative is termed *exposure latitude.*

The least amount of exposure that records sufficient shadow detail generally provides the best quality negative and is considered the ideal exposure. The use of a determined exposure index leads to the ideal exposure for a particular film and process combination. Generally, the use of the assigned ISO speed provides acceptable results.

Emulsion Definition

Several factors, including graininess, resolving power (resolution), and acutance, affect the definition or capability of an emulsion to produce a clear, sharp image.

GRAININESS.–The negative image consists of nearly an infinite number of density deposits of metallic silver. To the naked eye, these grains of silver appear as a smooth, continuous deposit; however, when the image is magnified significantly, a speckled, granular, or mottledeffect becomes apparent. This appearance of the enlarged image is called **graininess.**

The graininess of a negative depends upon the size of the silver halides in the emulsion, the exposure the emulsion received, and the clumping action of the metallic silver grains during development. Although each emulsion has an inherent grain size, the graininess effect in a negative can be minimized by giving the film correct exposure and proper development. As a general rule, slower speed emulsions have a finer grain (a smaller grain size) than faster speed emulsions.

The Eastman Kodak Company uses modem tabular, or T-grain, technology in some of their emulsions. In doing so, flat, tabular crystals are used which are very efficient in absorbing light. In T-grain emulsions, fewer silver halide crystals are needed, because the crystals have a relatively large surface area for light to strike, but are thin and contain a small amount of silver halides. These properties provide higher resolution and lower graininess compared to other films with the same relative film speed.

Not all black-and-white films form the final image in black metallic silver; for example, Ilford's XP-1 black-and-white film produces a dye image. The advantage of this technology is the film can be processed in color-processing chemicals along with color film and then printed on black-and-white paper.

RESOLVING POWER.–This is a term used to define the ability of an emulsion to record fine detail. The resolving power, or resolution, of an emulsion is expressed as line pairs per millimeter. Resolving power is determined by photographing a lined test chart at a greatly reduced size then counting the lines present in one millimeter of film.

ACUTANCE.–This is the ability of an emulsion to produce sharp edges between image density differences. Do not confuse this with the ability of an emulsion to produce sharp images controlled by lens focus. Although an image is in focus, the line between a

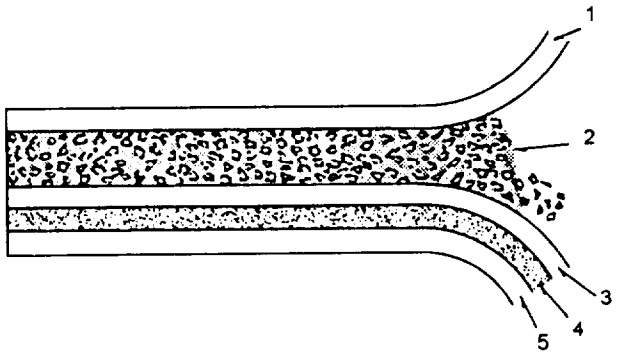


Figure 2-2.–Cross section of black-and-white film.

highlight area and a shadow area is not perfectly sharp. This is because the high-density area tends to "bleed" onto the low-density area due to the scattering or diffusing of light in the emulsion during exposure.

CONSTRUCTION OF BLACK-AND-WHITE FILM

Light-sensitive materials are composed of two basic parts: the emulsion and the base. The emulsion is the light-sensitive portion that records the image. The base is the support to which the emulsion is coated. Also, negative materials have additional layers that perform a special purpose. They are as follows: overcoating, antihalation backing, and noncurl coating (fig. 2-2). The purpose of the five parts of photographic film are as follows:

1. Overcoating–The overcoating protects the film from friction, scratches, or abrasions before development. The overcoating is a clear, gelatin layer that is sometimes called the antiabrasion layer.

2. Emulsion–thin layer of gelatin that suspends and supports the light-sensitive silver halides.

3. Base-This supports or holds the emulsion in place. The base may be transparent, translucent, or opaque, depending upon how the recorded image is to be used. The base is generally made of a cellulose acetate.

4. Antihalation backing-The antihalation backing prevents light from reflecting from the base back into the emulsion. The antihalation dye is sometimes incorporated in the anticurl backing. The dye used to eliminate halation is a color to which the emulsion is least sensitive. This dye is water soluble and is completely dissolved during processing.

5. Noncurl coating-The noncurl coating is a hardened gelatin, about the same thickness as the emulsion, and is applied to the back of the film. A film emulsion swells when wet and shrinks when dry. This contraction produces a strain on a film base because it is highly flexible. The noncurl coating prevents the film from curling during the drying process.

PROTECTIVE OVERCOATING
BLUE SENSITIVE EMULSION LAYER - PRODUCES YELLOW DYES
YELLOW FILTER - ABSORBS BLUE LIGHT
GREEN SENSITIVE EMULSION LAYER - PRODUCES MAGENTA DYES
RED SENSITIVE EMULSION LAYER - PRODUCES CYAN DYES
BASE
ANTIHALATION BACKING
NONCURL COATING

Figure 2-3.-Cross section of ordinary color negative film.

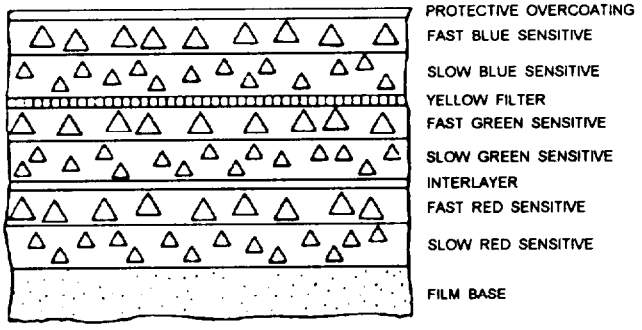


Figure 2-4.–Modern high-speed color film.

COLOR FILM

Modern color films are constructed much the same as black-and-white film, but color films consist of three separate emulsions on a single film base. Each of the three emulsion layers records one of the three additive primary colors-red, green, or blue. The top emulsion layer is sensitive to blue light and produces yellow dyes. Between the top emulsion layer and the middle emulsion layer is a yellow filter (fig. 2-3). The yellow filter absorbs the blue light that would otherwise affect the middle and bottom emulsion layers. During processing, this yellow filter is dissolved. The middle emulsion layer records green light and produces magenta dyes. The bottom emulsion records red light and produces cyan dyes. Many of the modern high-speed color films have fast and slow emulsion layers for each primary color (fig. 2-4).

In some color films where tabular-grain (T-grain) emulsions are used, high speed and increased sharpness are combined. When these films are manufactured, the overall thickness of the film is reduced By reducing the overall thickness, you also reduce the scattering of light within the film, resulting in improved sharpness. Also, double-emulsion layers, one fast and one slow, may be incorporated to improve film speed in color films.

Each emulsion layer of color film either has an incorporated dye coupler or a dye that is put into the emulsion during processing. A dye coupler is a chemical that produces a dye by combining with the oxidized products that occur during color developer.

Color Negative Film

A color negative film records a scene in image densities opposite to the brightness of objects in the scene-the same as a black-and-white negative film. Color films can be recognized because they contain the suffix "color," such as Vericolor, Kodacolor, and Fugicolor. These color films are used when a print is the final product. Most color negatives (other than color film used for aerial photography) have an orange mask This orange mask increases the color separation that reproduces colors more accurately in the final print.

During development, colors are formed in the emulsion that are complementary to the color of the original scene; for example, a red object in the scene is recorded as cyan in the negative. It is a combination of yellow, magenta, and cyan that records all the other colors that you see in the scene. Color dyes in the emulsion layers control the colors of light passing through the color negative.

Color negative film images can be printed on color positive materials, such as color paper and color print film, to produce color prints or color transparencies. Color negatives can also be printed on a special panchromatic black-and-white paper to produce black-and-white prints.

Color Reversal Film

Color reversal films produce positive images in densities directly proportional to the reflective brightnesses of objects and in the same colors as those in the original scene. Reversal films are recognized by the suffix "chrome" in their names, such as Ektachrome, Kodachrome, and Fujichrome.

The positive image of most color reversal film is produced by a two-stage development process. This process causes chemical fogging and color developing of the portions of the silver halide emulsions that were not affected by camera exposure or the first black-and-white developer. Like color negative film, color reversal film has three emulsion layers that are sensitive to blue, green, and red light and produces yellow, magenta, and cyan dyes, respectively. The film contains dye-forming chemicals that are put into the emulsion layers during manufacturing. A color developer produces three dye images in the emulsion layers. The three dye images in a developed color reversal film control the colors of light passing through the film.

Kodachrome film does not contain dye-forming chemicals in the emulsion layers. They are introduced during processing from three separate color developer solutions. Kodachrome film has high resolving power and tine grain and produces a fine image. Processing Kodachrome film is a complex operation and can only be performed by a Kodak processing plant.

Developed color reversal film can be used as a transparency (slide) for direct viewing, printed directly onto a color reversal paper, copied on a black-and-white film for producing black-and-white prints, or copied to a color internegative (copy negative) for producing color prints.

Color Balance

Color balance is the acceptable relationship among the three color images in a positive color print or slide. This means that when the color print or slide looks correct, color balance has been achieved.

To help achieve this acceptable relationship, the manufacturer balances color film emulsions for exposure with a specific Kelvin temperature (K). Remember, daylight usually has a higher content of blue light than red light, while tungsten illumination usually has a higher content of red light than blue light. To compensate for the lower proportion of red light in daylight, the manufacturer balances color films for daylight, so they have a higher sensitivity to red light than to blue light. To compensate for the lower proportion of blue light in tungsten illumination, the manufacturer balances color films for tungsten illumination, so they have a higher sensitivity to blue light than to red light.

Generally, color films are referred to as daylight (outdoor) or tungsten (indoor), indicating their broad use without filters. Specifically, daylight films are balanced for use in sunlight or with an electronic flash

that averages approximately 5400 K. Tungsten films are balanced for use with illumination of 3200 K without filtration.

The Kelvin temperature of the exposing light for reversal films is much more critical than the color of the exposing light for color negative films. When an exposing light is used other than that for which color negative film is balanced, adjustments to the filter pack can be made during printing to achieve proper color balance. With color reversal film, however, a slide is usually the final product. When the color of the exposing light is other than that for which the film is balanced, the transparencies are off-color. You should strive to expose all color films with the color light for which the films are balanced.

Although color films have three separate emulsions, only one ISO film speed is assigned. An ISO film speed for color film is most accurate when the illumination used is the one for which the film is balanced.

Amateur and Professional Color Films

Much of the color film used in the Navy is manufactured by Eastman Kodak Company. Kodak markets color films for both professional and amateur photographers. Color films intended for use primarily by professionals are identified by the word *professional* in the name; for example, Kodak Vericolor III Professional Film, Type S (VPS).

Both professional and amateur films have similar color quality, sharpness, and granularity characteristics. Also, they have emulsions made up of many different chemicals that tend to change slowly with time. Starting from the day they are made, all color films begin to change; and as the films age, their color balance changes.

Amateur films are manufactured to age and reach a peak color balance much later than professional films. The manufacturer allows for the time amateur film will be in storage, on the store shelf, and in the camera before it is developed. The ISO speed assigned is adequate for calculating exposure for normal picture-taking situations.

Professional films are manufactured so they are very near their optimum color balance at the time they are shipped from the factory. These films should be kept refrigerated or frozen until shortly before use. Refrigeration keeps film near the optimum point until used and provides the photographer with confidence in consistent results. Precise film speeds are provided for professional films. The film is intended for prompt processing to prevent any significant shift in color balance after exposure.

If you require optimum color balance and precise film speed within about 1/6 f/stop professional film is appropriate for your work; however, when you intend to be away from home base for an extended period of time without refrigerated storage or processing facilities, amateur film should be your choice.

Instant Picture Film

Currently, the only manufacturer of instant picture film is Polaroid. There are two basic types of instant picture film: peel apart and integral. After exposure and removal from the camera, peel-apart film must be timed while the film develops. After it has developed for the specified period of time, the negative backing is peeled away and discarded. Integral films develop outside the camera and have no negative backing to be removed.

Instant picture color films are tripack materials with built-in processing. Peel-apart film uses a system whereby the exposed silver halides develop to a metallic silver negative. When no metallic silver is present, dyes pass to form the color image. Integral films use a reversal process in which the areas of unexposed silver halides are the locations where the dyes are produced to form the positive image.

Instant picture film is a very useful medium in an imaging facility, particularly when still electronic technology is not available. Instant picture film is used commonly for identification and passport photographs, but it is also valuable in determining test exposures. Before you make your final exposures on conventional film, a Polaroid photograph can be taken to confirm composition, lighting, and exposure.

FILM SIZES

There are two types of film formats used commonly in photography. They are roll film and sheet film. Both formats come in a variety of sizes.

Roll Film

All roll film is packaged so the film can be loaded and unloaded from a camera in daylight. Number 120 film has a paper backing that prevents the film from being exposed in daylight; 35mm film is wound in a lighttight cassette that prevents the film from being exposed by ambient light.

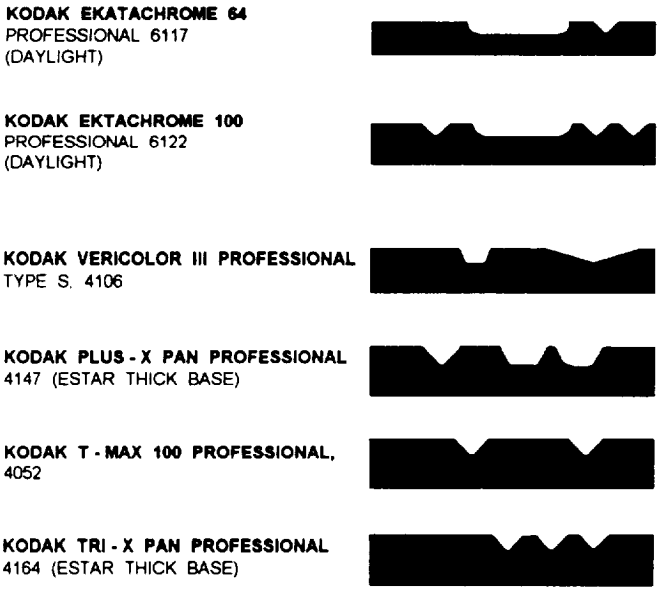


Figure 2-5.–Notch codes used to identify the type of film.

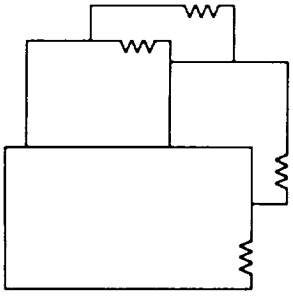


Figure 2-6.–Location of notch code that indicates the emulsion is toward you.

The most popular medium-size format film is No. 120. This film, depending on the camera format, provides negatives that are 6x6 cm (2 1/4 x 2 1/4 inches), 4.5x6 cm, or 6x7 cm. No. 220 roll film is used for making the same size negatives, but because most of the paper backing is eliminated, the roll is longer than a 120 roll and provides twice as many frames as 120 film.

Still picture 35mm films come prepackaged in cassettes in lengths for producing 12, 20, 24, and 36 frames per roll. Also, 35mm films come in rolls 100 feet long that can be bulk-loaded into reusable cassettes.

Sheet Film

Sheet or cut film is made in a variety of sizes from 4x5 to 11x14 inches and larger. The most common sizes are 4x5 and 8x10 inches. Most sheet film has no paper backing and must be loaded into and removed from film holders in the darkroom in total darkness or under the appropriate safelight. Eastman Kodak does market the Kodak Readyload Packets that provide two sheets of film in a paper packet. These packets can be loaded into a Kodak Readyload Packet film holder or a Polaroid film holder, Model 545. The Kodak Readyload Packets are available only in 4x5 format.

Most sheet films have reference notches in one edge of the film. In the dark, this allows identification of the film type and the emulsion side of the film. Every film type has a different notch code (fig. 2-5). The emulsion side of the film is toward you when the notches are along the top edge in the upper right-hand corner, or on the bottom right edge in the lower right-hand corner of the film (fig. 2-6).

For those sheet films that do not have notches, the emulsion side of the film can be identified under a safelight. The emulsion side is lighter in color than the base side. If the emulsion side of the film must be identified in total darkness, wet your lips and place the edge of the film between them. The emulsion side of the film will stick to one of your moistened lips.

FLOPPY DISKS

Although the floppy disks used in electronic imagery are not light sensitive, they are, however, a commonly used image-recording medium. All floppy disks are the same. There are no black-and-white and color floppy disks. The camera and the printer being used determine whether the image is black and white or color. Images are stored as magnetic impulses on compact 2-inch still-video floppy disks.

The pictures are recorded on tracks on a still-video floppy disk. Each picture is recorded either as a FRAME or FIELD (the frame or field mode is selected on the camera). When the frame mode is selected, each picture is recorded on two tracks. Twenty-five images can be recorded on a floppy disk in the frame mode. When the field mode is selected, each picture is recorded on one track In the field mode, 50 images can be stored on each disk. The result of using one track per photograph is the images are less detailed than those recorded on two tracks (frame mode). The quality of the frame-recorded image is superior to that of the field-recorded photograph. A combination of field and frame images can be stored on the same disk; however, for higher quality use the frame mode.

Sound can also be recorded on a floppy disk. Sound is not recorded on the same track as the image. It is recorded right after the image is recorded. The sound

associated with the picture can be heard during playback

Floppy disks used in electronic imaging can be reused for endless times-the same as any other magnetic recording medium. No chemicals or darkroom techniques are required to produce these images. Once the image is captured on the floppy disk, it can be transmitted over the telephone lines, edited, and printed using a video printer-all under normal room-lighting conditions.

BLACK-AND-WHITE PRINTING PAPER

The performance and use of black-and-white photographic printing paper, like black-and-white films, depends on the characteristics of the paper material. While the many types of photographic papers differ in their characteristics, they all basically consist of the emulsion on a paper support or base. Photographic printing papers (both black and white and color) are manufactured in both various cut sheet sizes, ranging from 5x7 to 20x24 inches and rolls up to 1,000 feet long.

Photographic papers used in Navy imaging facilities are either coated with polyethylene or are resin-coated. These papers are coated on both sides of the base. This clear coating is treated so the paper does not stick to the surface of other prints during processing. Polyethylene-coated papers (manufactured by Ilford) can be marked on with pencils and pens. Coated papers have water-resistant bases that provide short processing times. Most black-and-white papers with these coatings have developing agents incorporated in the emulsion. The developing agents are activated when the paper is exposed to an alkali solution. The characteristics of resin-coated paper make it ideal for machine processing, but they may also be tray-developed in a regular print developer.

The image on black-and-white film is usually negative or recorded in tones of gray in reverse of the reflective brightness values of a scene. When the negative image is projected onto black-and-white paper, the resulting image is positive or recorded in tones of gray relative to the reflective brightness values of the original scene. A negative is usually used or viewed by transmitted light. A paper print (or simply a print) is usually viewed by reflected light and may be referred to as a reflection print or reflection positive.

Emulsion Sensitivity

The emulsions used for printing paper are much slower (less sensitive to light) than most film emulsions.

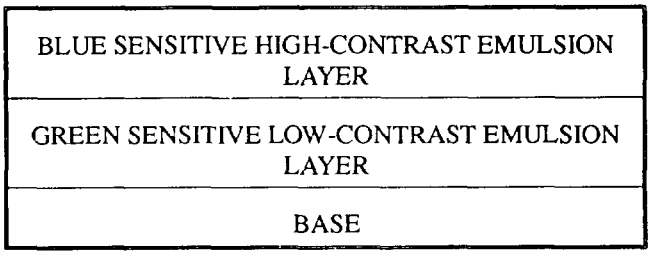


Figure 2-7.–Cross section of variable-contrast black-and-white paper.

A high sensitivity to light is not needed. Prints are often manipulated by providing additional exposure or by holding back exposure to selected areas of the print. If the paper emulsions were fast, exposure times would be extremely short and print manipulation would not be possible.

The color or spectral sensitivity of a paper emulsion indicates the response to specific colors of light or radiation-the same as that for a film emulsion. The terms *colorblind, orthochromatic,* and *panchromatic* are also used to describe the spectral sensitivities of paper emulsions. The response of a paper emulsion to wavelengths other than ultraviolet radiation, violet, and blue light is achieved by the addition of sensitizing dyes to the emulsion during manufacturing.

The ranges of sensitivity for all paper emulsions begin in the near-ultraviolet region of the invisible portion of the electromagnetic spectrum. The color sensitivity of undyed silver emulsions extend to blue and blue-green. Panchromatic printing papers are sensitive to ultraviolet radiation, violet, blue, green, and red light. The color sensitivity of a black-and-white paper is NOT a determining factor for selecting a paper to print a specific black-and-white negative. Panchromatic papers, however, are normally used to produce black-and-white prints from color negatives. Color sensitivity DOES determine whether or not a safelight is required an, if so, what color of safelight can be used.

Variable Contrast Papers

Variable contrast papers are used almost exclusively in Navy imaging facilities. The contrast of the print image on variable contrast papers is controlled by the specific color of the exposing light. Variable contrast papers have two emulsion layers. The top layer is a high-contrast emulsion and is sensitive to blue light. The second emulsion layer is a low-contrast emulsion and is sensitive to green light (fig. 2-7). When a normal contrast negative is exposed through a variable contrast filter with blue light, a harsh, contrasty print is produced.

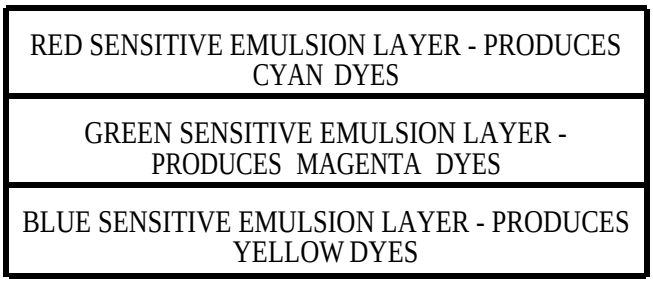


Figure 2-8.–Cross section of color printing paper.

When the same negative is exposed on another sheet of paper with green light, a flat or not enough contrast print is produced. When the normal-contrast negative is printed with the proper combination of blue and green light, a print with natural contrast is produced; therefore, to control contrast when using variable contrast papers, you can use a series of yellow and magenta filters to control the amount of blue and green printing light during exposure.

COLOR PRINTING PAPERS

Color printing papers are for printing color negatives or color transparencies. Like color negative films, color printing paper can be identified by the suffixes "color" and "chrome." These papers are designed for printing color negatives and color transparencies, respectively.

Like color films, color papers have three emulsion layers. The order of the emulsions is reversed in comparison to color films (fig. 2-8). The top emulsion layer is sensitive to red light and produces cyan dyes, the middle emulsion layer is sensitive to green light and produces magenta dyes, and the bottom emulsion layer is sensitive to blue light and produces yellow dyes.

PAPER SURFACES

Photographic papers are available in a variety of paper surfaces, such as matt, semimatt, lustre, high lustre, pearl, and glossy. The use of different paper surfaces depends on the final application of the photograph. There are two paper surfaces that arc used frequently in Navy imaging facilities: glossy and matt. Paper that has a smooth, glossy surface provides a print with higher contrast and higher densities or color saturations, resulting in an apparently sharper image. This is due to the direct reflection quality of the paper surface (fig. 2-9, view A). Glossy papers are always used for photographic prints that are used to show fine detail, such as equipment damage or intelligence photographs.

Light reflected from MATT paper is diffused and provides a softer, lower contrast image (fig. 2-9, view B). Because of the lower contrast, subject detail does not appear as sharp as an image on glossy paper. Matt papers are used commonly for portraiture and scenic photographs.

PROPER HANDLING AND STORAGE OF FILMS AND PAPERS

Care in handling films and papers prevents fingerprints, abrasions, and scratches on the surfaces of these materials. You should particularly avoid unnecessary contact between an emulsion surface and any other object. Only handle light-sensitive materials by the edges.

Light-sensitive materials should be removed from their packages in a room that is clean, dust-free, and lightproof. The workbench and your hands should be clean and dry. Light-sensitive materials should be

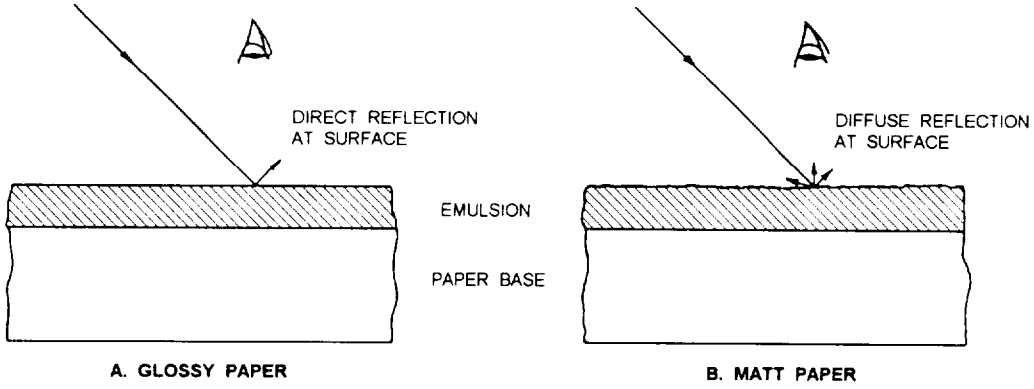


Figure 2-9.–Reflection of light of different surface paper.

handled in total darkness or under safelight conditions specified by the manufacturer.

Unexposed light-sensitive materials deteriorate slowly with time even when the materials are stored under ideal conditions. High temperatures and high relative humidity accelerate this deterioration. You should protect light-sensitive materials from the harmful effects of temperature, humidity, x rays, gases, and vapors that may be present in darkrooms, transport, and adverse storage conditions. Storage instructions are printed on the packaging materials of most photographic products.

Kodak papers and sheet film are packaged in humidity-sealed boxes to protect them from changes in relative humidity (RH). Keep these materials in their original packaging until you are ready to use them. When the RH gets at 60 percent or higher for long periods of time, not only do cardboard packages, labels, and metal containers become damaged, but mold, fungus, and bacteria start to grow. Fungi can destroy film and paper by digesting the gelatin in them. Ideally, film and paper should be stored below 50 percent RH.

The usable life of a light-sensitive material varies with the type of material, but generally, color materials deteriorate more rapidly than black-and-white materials, and black-and-white materials with high-speed emulsions deteriorate more rapidly than black-and-white materials with slow-speed emulsions.

Cold storage in a refrigerator or freezer is recommended for all light-sensitive materials; however, refrigerators and freezers that contain food or unsealed containers of liquids have a high relative humidity. Therefore, food should never be stored in the same refrigerator as film and paper.

Paper and professional film should be stored at about 50°F (10°C) or lower in the original sealed package. All film, including amateur film, must be protected from extreme heat. Never store photographic materials in extreme heat, such as in a glove compartment, trunk, or the back window of a car. Once opened, the original package should be used as soon as possible. After opening, the materials are no longer protected from humidity or chemical fumes.

When film or paper, black and white or color, is removed from cold storage into a warmer atmosphere, allow a warm-up time before opening the original packaging; otherwise, moisture condensation may form on the film or paper. The warm-up time for light-sensitive material depends on the type of material packaging, the size of the package, and the amount of material.

The warm-up times for packages of paper is considerably longer than for film. Paper is usually packaged in larger quantities, 100 to 500 sheets per box and in rolls up to 1,000 feet long. Short roll film and magazines take 1 to 1 1/2 hours to warm-up. Large packages and rolls of film and paper should be allowed to warm-up to room temperature overnight or about 10 hours.

FILM AND PAPER EXPIRATION DATES

Each package of film is marked with an expiration date. Ideally, the film should be processed before this date for best results. If the film has not been used by this date, it should be tested photographically to confirm and determine its adjusted film speed and performance. Much of the film and paper found in Navy inventory has, in fact, expired. When not subjected to adverse storage and handling conditions, the film is probably still usable for a reasonable time. You should consider the expiration date as a guide only.

Use light-sensitive materials of the same type in the order of their expiration dates. The material with the earliest expiration date should be used first. One exception to this is when you know that a material of the same type with a later expiration date has been subjected to improper storage conditions; for example, if film or paper has been sitting on a pallet on the flight ramp in Diego Garcia for several weeks before being delivered to the ship, you should test the material before using it. Film and paper stored under unfavorable conditions or film that has expired may have a loss of emulsion speed, undesirable contrast changes, stains, color shifts, or high gross fog.

CHAPTER 3

PHOTOGRAPHIC FILTERS

Filters are used in all the various steps of the photographic process. Though often neglected in the shooting stage, the use of filters can tremendously enhance the final product in both black-and-white and color photography.

PURPOSE OF PHOTOGRAPHIC FILTERS

The purpose of photographic filters is to alter the characteristics of light that reaches the light-sensitive emulsion As light is transmitted through a filter, at least one of the following alterations occurs:

1. The color of light is modified.
2. The amount of light is reduced.
3. The vibration direction of the light rays is limited.

The two most important reasons for using photographic filters are to create an effect with an emulsion and to control the exposure of an emulsion. Interlocked with the use of filters are characteristics of light and characteristics of photographic emulsions. The effectiveness of a filter depends upon the ability of an emulsion to respond to the color of light transmitted by the filter.

Colored filters modify the way colors are recorded. Without the use of filters, black-and-white panchromatic film records colors as gray tones. These gray tones correspond roughly to the tonal range as seen by the human eye. Colored filters selectively brighten or darken these tones. In color photography, colored filters are used to correct or distort color balance.

Filters of a specific color transmit most of the light of that color and partially or completely absorb light of all other colors. For example, a red filter transmits red light and may partially or completely absorb blue and green light, depending on the deepness or purity of its color (fig. 3-1). Likewise, a yellow filter transmits red and green light and partially or completely absorbs blue light. Remember, a secondary color of light is produced by combining two primary colors of light. Red and green equal yellow; thus a yellow filter passes red and green light.

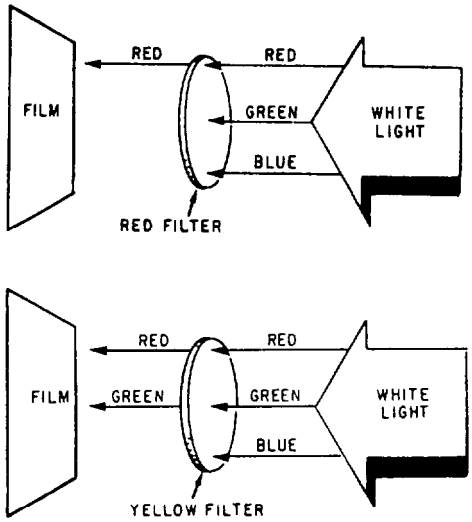


Figure 3-1.–Red and yellow filters.

Filters are available in three forms: optical glass disks bound with metal rims, lacquered gelatin film squares, and glass squares. Glass disk filters are the most practical for general use. They are available in different sizes called series numbers, such as Series 4,5, and 6 or in millimeter sizes, such as 52mm and 59mm. Glass disk filters attach to a camera lens in two ways. Some have threads and screw directly into the lens barrel, and the others are held on the lens barrel by an adapter ring. Gelatin filters and square filters made of glass are either inserted into special filter holders that are part of the camera, or they are held on the camera by a square filter holder.

FILTER DESIGNATIONS

Filters are usually identified by numbers. This system of designating filters is used to identify Kodak Wratten filters. It uses designators, such as No. 6, No. 8, and No. 11. Some filters have a descriptive name rather than a number; for example, polarizing, skylight, and neutral density. Color compensating and color print filters have yet another designation system.

FILTERS FOR BLACK-AND-WHITE PHOTOGRAPHY

Filters used with black-and-white film are classified as contrast, correction, and special purpose. All contrast and correction filters have a noticeable color. It is important to note that a filter must be used with an emulsion sensitive to the specific color of light it transmits. Colored filters should normally be used with black-and-white film only.

Special-purpose filters for black-and-white film may be colorless, contain a hint of color, be noticeably colored, or almost visually opaque. Some special-purpose filters can be used with both black-and-white and color film. Special-purpose filters are covered later in this chapter.

Contrast Filters

Contrast filters are available in all colors and are designed to exaggerate, reduce, or eliminate specific colors of light. As their name indicates, these filters are used to increase or decrease contrast in a negative that provides differences between tones in the print.

To illustrate this, compare a red apple and a yellow banana in a black-and-white print. With a red filter over the camera lens, the apple appears lighter on the print than the yellow banana. Both objects in this example reflect the same intensity of light.

When you look through a red filter, the filter definitely appears red. This color is the effect it produces in your eye and the reason it is called a red filter. The red filter is transmitting most of the red part of the spectrum, some yellow, and some magenta. The color it is not transmitting is cyan. If you think of this red filter as an anticyan (blue and green) filter, you will better understand the way it works.

When a red filter is used, most of the reflected red light from the red apple is transmitted through the filter and recorded as a dense area on the film. Only a portion of the yellow light is transmitted, so it is recorded as a less dense area on the film. Only some of the yellow light is transmitted because the reflected light from the banana consists of red and green light. Although the red portion of the yellow light is readily transmitted through the red filter, the green portion is absorbed to some degree. Thus less light from the yellow banana reaches the film emulsion.

When the negative is printed, the two print images have separation in contrast because of the differences in negative densities. The print image of the apple is lighter than the print image of the banana because the negative image of the red apple is more dense than the negative image of the yellow banana.

When using a specific color of contrast filter to provide separation between black-and-white images of colored objects, you should also take into account what effect the filter has on the images of other colored objects in the scene. For example, when there are blue and green objects in the scene, the red filter absorbs some or all of the reflected blue and green light. The red filter renders the negative images of these objects as low-density areas. Thus the print images have darker tones or densities.

Contrast filters can also be used to filter out an image or filter out the image of a transparent stain on an original document by copying it. This filtering-out process takes place by blending or matching the density of the image to be filtered out with the image density of the surrounding area For example, to eliminate the image of a yellow line on a white background, use a yellow filter. The yellow filter should be as deep (same color density) or deeper in color than the color of the line. The yellow filter reduces the intensity of the light reflected from the white background by absorbing blue light. The intensity of the light reflected from the yellow line is not greatly affected since the yellow filter readily transmits the yellow light. The reduction of the intensity of the light reflected from the white background and the intensity of the light reflected from the yellow line produces equal densities on the negative and thereby does not render an image of the yellow line. Conversely, when the yellow line is on a black background, a blue filter does not allow yellow light to be transmitted. Therefore, light from the yellow object is not allowed to affect the film emulsion. Thus the line appears as a thin area that matches the black background and is thereby "eliminated"

Stains on a drawing or a picture can be filtered out whenever the stain is transparent and reasonably pure in color. The filter should be approximately the same color as the stain. The stain may still show in the negative but, in the case of line material, proper paper contrast and printing exposure get rid of the rest of the stain image.

Remember, the color of filter required to eliminate the image of an object or stain is determined by the color of the object or stain and the darkness or lightness of the surrounding scene area. Also, always use a filter that is as deep or deeper in color than the color of the object or stain to be eliminated. Refer to table 3-1 for clarification on ways to use contrast filters.

Table 3-1.–Parallel Filter Bars

Filter Color and No.		Filter Color and No.	
Deep Red	29	Bluish Green	65
Red	25	Bluish Green	65
Light Red	23A	Cyan	4
Orange	21	Cyan	44
Deep Yellow	15	Blue	47
Yellow	8	Deep Blue	47B
Yellowish Green	11	Violet	34A
Yellowish Green	13	Violet	34A
Green	58	Magenta	33
Green	61	Magenta	33

Use the parallel filter bars to choose contrast filters for black-and-white photography. Adjacent filters lighten colors next to them. Opposite filters darken colors in the print; for example, a yellowish green No. 11 filter lightens subjects that are yellowish green or yellow and darkens subjects that are violet. A No. 44 cyan filter lightens blue and blue-green and darkens light red and orange.

Correction Filters

Although panchromatic film responds to all the colors the eye can see, it does not reproduce tones of red, green, and blue objects in the same relative values as the eye sees them. The human eye is much more sensitive to green than it is to blue and red, and these colors look darker to the eye than green (fig. 3-2). Panchromatic film is more sensitive to blue and violet and looks lighter than green in a black-and-white print. This high sensitivity to blue and violet causes an overexposure to the film of blue objects as compared to green objects. This overexposure causes a dense negative image that results in a light print image (fig. 3-3).

A No. 8 yellow filter with panchromatic film helps to reproduce colors of a daylight scene with the same brightness relationship as seen by the human eye.

When using tungsten lighting, you can use a yellowish green No. 11 filter to reproduce the natural brightness relationship with panchromatic film. The yellow in the filter absorbs the ultraviolet radiation and some of the blue light, while the green in the filter absorbs some of the red light.

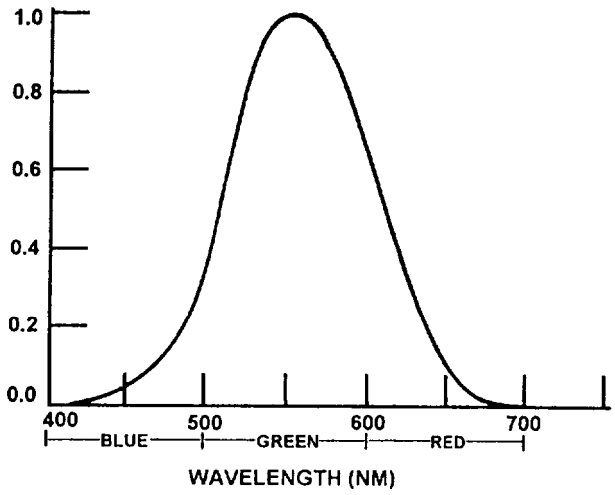


Figure 3-2.–Color sensitivity of the average human eye.

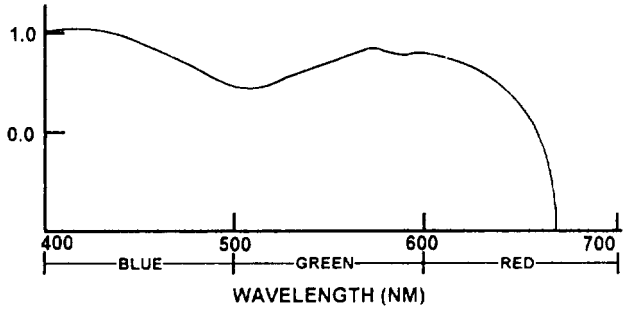


Figure 3-3.–Color sensitivity of panchromatic film.

Table 3-2.–Recommended Filters for Use with Black-and-White Panchromatic Film in Daylight

Subject	Desired Effect	Filter to Use	
Blue Sky	Natural	Yellow	No. 8
	Darken	Deep yellow	No. 15
	Very dark	Red	No. 25
	Near black	Deep red	No. 29
Seascape when sky is blue	Natural	Yellow	No. 8
	Dark water	Deep yellow	No. 15
Sunset	Natural	None/yellow	No. 8
	Brilliance	Deep yellow	No. 15
		Red	No. 25
	Added haze for distant effect	Blue	No. 47
Landscapers	Natural	Yellow	No. 8
	Reduce haze (little)	Deep yellow	No. 15
	Reduce haze (a lot)	Red	No. 25
		Deep red	No. 29
Green colors	Natural	Yellow	No. 8
	Light	Green	No. 58
Reddish colors	Lighter	Red	No. 25
Bluish colors	Lighter	Blue	No. 45
Wood, stone, sand, snow, fabrics, etc.	Natural	Yellow	No. 8
	Render texture	Deep yellow	No. 15
		Red	No. 25

To obtain desired effects with the use of filters, refer to table 3-2.

FILTERS FOR COLOR PHOTOGRAPHY

Problems associated with color materials are quite different from those encountered with black-and-white materials. In color photography, the main problem is achieving correct color balance. The principal factor involved is the color temperature of the light source being used to illuminate the subject. This color temperature provides a natural appearance to the final product. Filters for color photography are classified as light balancing, conversion, and color compensating.

LIGHT BALANCING FILTERS

Light balancing filters come in two series (not to he confused with a series that indicate physical size): the Series 81, yellowish filters, are used to lower the color temperature of a light source; and the Series 82, bluish filters, are used to raise the color temperature of light from a light source. Both series are used when a tungsten light source is used with color film.

These two series of filters permit minor adjustments in the color quality of an exposing light to obtain cooler (bluer) or warmer (more yellow) reproduction of colors; for example, when the color temperature of a tungsten light source is 3100 K and a color temperature of 3200 K is desired for the exposing light, a Series 82

Table 3-3.–Light Balancing filters

Filter color	Filter number	To Obtain 3200 K from:	To Obtain 3400 K from:
Yellowish	81	3300 K	3510 K
	81A	3400 K	3630 K
	81B	3500 K	3740 K
	81C	3600 K	3850 K
	81D	3700 K	3970 K
	81EF	3850 K	4140 K
Bluish	82C+82C	2490 K	2610 K
	82C+82B	2570 K	2700 K
	82C+82A	2650 K	2780 K
	82C+82	2720 K	2870 K
	82C	2800 K	2950 K
	82B	2890 K	3060 K
	82A	3000 K	3180 K
	82	3100 K	3290 K

color balancing filter can be used to raise the color temperature 100 K. Light balancing filters affect the entire visible spectrum of tungsten light and provide an adjustment from one Kelvin temperature to another.

When the color temperature of a tungsten light source is unknown, you can use a color temperature meter to determine it. When trying to determine what light balancing filter to use for producing a particular color temperature with a given light source, you may use the following methods:

1. Refer to the scale on a color temperature meter.
2. Refer to the tables in the *Photo-Lab-Index.*
3. Consult the manufacturer's publication for a particular filter or meter.
4. Consult appropriate film or filter data sheets.

Light balancing filters are Series 81 and Series 82. Refer to table 3-3 to determine light balancing filters that can be used to raise or lower the color temperature of a given color.

CONVERSION FILTERS

Conversion filters are used in color photography when a significant adjustment of an exposing light is required to convert the color quality of the exposing light to the color temperature for which a film is balanced.

Conversion filters generally come in two series. The 80 series of filters are blue in color and convert tungsten light to color qualities acceptable for use with daylight film. The 85 series of filters are amber in color and convert daylight to color qualities acceptable for use with tungsten film.

The correct filter to use for a given situation with a given film can most accurately be determined by consulting conversion filter tables in the *Photo-Lab-Index* or reading the filter and film data sheets.

COLOR COMPENSATING FILTERS

Color compensating (CC) filters are used to adjust the overall color balance obtained from color film, particularly slide film. Without the use of color compensating filters, improper color cast can result.

For cameras, CC filters are normally used to color balance the light from sources, such as fluorescent, tungsten, and mercury-vapor lights, and the "bounce" light reflected from colored surfaces. They are also used to balance lighting effects under unusual circumstances; for example, underwater lighting. These filters can be used to compensate for a known color deficiency of an unexposed color film. They can also be sandwiched (layered) when mounting a color transparency to compensate for an off-color hue.

Table 3-4.–Filters and Exposure Increase for Making Color Pictures by Fluorescent Light

Type of fluorescent lamp	Type of color film	
	Daylight	Tungsten
Cool White	30M + 2/3 f/stop	50M + 60Y + 1 1/3 f/stops
Deluxe Cool White	30C + 20M + 1 f/stop	10M + 30Y + 2/3 f/stop
Standard Warm White	40C + 40M + 1 1/3 f/stops	30M + 20Y + l f/stop
Deluxe Warm White	60C + 30M + 1 2/3 f/stops	10Y + 1/3 f/stop
White	20C + 30M + 1 f/stop	40M + 40Y + 1 f/stop
Daylight	40M + 30Y + 1 f/stop	No. 85B + 30M + 10Y + 1 f/stop

Whenever possible, you should conduct photographic tests in advance, using the type of light you expect to encounter. Consult the *Photo-Lab Index* for the most accurate filtration to use for your film, filter, and lighting situations. Table 3-4 provides an example of a good starting point for test exposures. When in doubt, you should use a filter that provides for average correction. For daylight film, you should use a 30M filter with a 2/3 f/stop exposure increase. For tungsten film, you should use a 50R filter and a 1 f/stop exposure increase.

CC filters may be used alone or in various combinations. However, when you use them in combination, the maximum number of filters in front of a lens should not exceed three. More than three filters adversely affect image quality. When combining CC filters, you should avoid creating a neutral density effect. Neutral density is caused when all three of the primary colors are present in the combined filters; for example, a cyan (blue and green) filter and a red filter.

CC filters are available in blue, green, red, yellow, magenta, and cyan. Each color is available in a range of densities. The color and density of a CC filter are identified in the filter designation, such as CC50Y. The CC indicates color compensating, the 50 indicates a peak density of 0.50 to blue light, and the Y is the first letter of the filter color-yellow. The peak density of a CC filter refers to the maximum absorption of the color of light that is complementary to the color of the filter. CC filters are available only in gelatin squares.

The color star (fig. 3-4) indicates various color relationships of color compensating filters as follows:

1. Complementary colors are opposite each other: cyan is complementary to red, yellow is complementary to blue, and magenta is complementary to green.

2. Any one color is a combination of the two colors adjacent to it:

R = M + Y

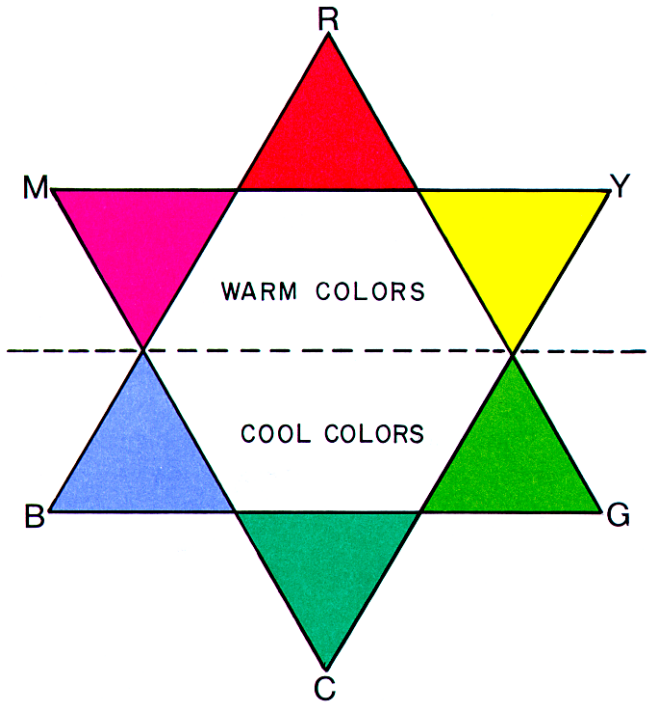
Y = R + G

G = Y + C

C = G + B

B = C + M

M = B + R



C302.24

Figure 3-4.–Color star.

THIS PAGE MUST BE PRINTED ON A COLOR PRINTER.

3. The warm colors are at the top of the horizontal axis. The cool colors are at the bottom.

4. Filters of the same color are added and subtracted normally:

30M + 20M= 50M

10B - 05B = 05B

5.When two filters of different colors and equal densities are combined, the color of the combined filters changes, but the peak density remains the same.

10M + 10C = 10B

10R + 10G = 10Y

6. A filter combination having all three primary colors creates neutral density. To correct this neutral density, subtract the lowest density from each color.

10R + 20G + 30B

-10 -10 -10

0R + 10C + 20B (Results)

SPECIAL-PURPOSE FILTERS

Special-purpose filters for use with black-and-white film are those filters not classified specifically as contrast or correction filters. Some of the special-purpose filters can be used with both black-and-white and color film. Two of these special-purpose filters are intended primarily for use with color film.

NEUTRAL DENSITY FILTERS

Neutral density (ND) filters reduce the amount of light passing through a camera lens without changing the reproduction of colors in the scene. These filters are nonselective in their absorption of colors of light and therefore uniformly reduce the various colors of light in the spectrum. Thus white light and colored light are transmitted through an ND filter with only the intensity of the light being affected. These filters can be used with both black-and-white and color film. Neutral density filters are gray in appearance. These filters may be needed for pictures being made of a brilliant subject in bright sunlight. When you have set the fastest shutter speed and the smallest f/stop and still cannot make the picture without overexposing the film, you can use an ND filter to further reduce the exposure. Neutral density filters manufactured by Kodak are called Wratten Neutral Density Filters and are available in several densities. The ten most popular densities, with the amount of exposure reduction provided, are shown in table 3-5.

Table 3-5.–Neutral Density Filters

Density	Exposure reduced by f/stops
.10	1/3
.20	2/3
.30	1
.40	1 1/3
.50	12/3
.60	2
.70	2 1/3
.80	2 2/3
.90	3
1.00	3 1/3

When you desire to reduce the depth of field but maintain a given shutter speed, ND filters permit the use of a larger f/stop which in turn, reduces the depth of field. Neutral density filters are used extensively in motion-picture photography where depth of field is usually quite deep. ND filters are also used with mirror type of lenses where there is no aperture control.

HAZE FILTERS

Suspended in the earth's atmosphere are minute particles of vapor and dust that cause a veil-like appearance called haze. This haze is most apparent in distant scenes. Haze is the result of sunlight being scattered by minute particles of matter that are present in the air. The amount of haze can vary due to atmospheric conditions. Haze should not be confused with mist, fog, smog, smoke, or clouds. These conditions can also produce a veil-like appearance, but filters have no effect.

When sunlight is scattered, both green light and red light are also scattered by the ever-present haze, but not nearly as much as ultraviolet radiation, violet, and blue light.

When filters are used to absorb scattered sunlight, penetration of the haze is possible. A haze filter is any filter that absorbs atmospherically scattered sunlight. A

haze filter includes contrast and correction filters. When contrast and correction filters are used for haze penetration, they may be considered special-purpose filters. Although contrast filters can be used for cutting haze, these filters affect the gray tone rendering of colored objects. The contrast and correction filters that absorb the shorter wavelengths are the most effective. The recommended contrast and correction filter colors, in the order of greatest to least effective for haze penetration, are as follows:

Red

Orange

Yellow

Green

The use of an infrared sensitive black-and-white film with an infrared filter provides the greatest haze penetration of all. Special, visually opaque infrared filters completely absorb the scattered ultraviolet radiation and the visible light that produce haze. This absorption by an infrared filter allows the scene to be photographed entirely with unscattered infrared radiation. An infrared sensitive black-and-white film without an infrared filter, or at least a red contrast filter, is not effective for haze penetration. Infrared black-and-white film is sensitive to ultraviolet radiation, violet, and blue light as well as infrared radiation and red light. The gray tone rendering of a colored subject in a black-and-white print produced from an infrared negative is greatly distorted or contrasty.

The visually opaque infrared filters are identified by numbers as follows:

87

87A

87B

87C

88A

89B

When the effect of haze is to be reduced with an equal change to the gray tone rendering of all colored objects in a black-and-white print, filters that primarily absorb ultraviolet (UV) radiation are required. These filters have a very pale pink or yellow tint and may be identified by numbers as follows:

2A

2B

2C

2E

Colorless haze or ultraviolet absorbing filters are often used to protect the front element of a lens from damage. It is much cheaper to replace a filter than it is to repair or replace a lens.

The polarizing filter is another type of special-purpose filter that can be used to reduce the effects of haze.

POLARIZING FILTERS

Polarizing filters look like gray neutral density filters. However, their effect becomes apparent when you look at the blue sky through a polarizing filter while rotating it. As you rotate the filter, the sky appears to get darker, then lighter.

Polarizing filters are used in black-and-white and color photography for the following reasons:

1. Reduction or elimination of unwanted reflections (glare) from nonmetallic surfaces, such as glass and water

2. Exposure control, similar to ND filters

3. Reducing the effects of haze

4. Darkening the blue-sky image in both black-and-white and color photography

5. Increasing color saturation in a color photograph without altering the hues of image colors

As discussed in chapter 1 of this training manual, the term *polarize* refers to a property of light that cannot be seen-the direction in which light rays vibrate. Unpolarized light rays vibrate in all directions at right angles to the ray itself. A light ray is polarized when vibrations are in one direction only.

Any synthetic material that polarizes light may be called a polarizer, or polarizing device. A polarizing screen is a polarizer in sheet form.

There are a number of different polarizing filters. However, there are only two main types: one type fits over the camera lens and the other is designed to be used over a light source. Since they do not affect color, polarizing filters and screens may be used for both black-and-white and color photography. A polarizing device used over the camera lens may have small posts (known as indicator handles) projecting from the rim for aligning the axis of the polarizing grid.

The polarizing filter may be thought of as a screen, with an optical grid or slots, that stops all light that is not vibrating in a plane parallel to the axis of the grid lines.

As the filter is rotated, the amount of polarized light can be controlled. When the rodlike crystals are perpendicular to the vibration direction of the light, the polarized light is greatly absorbed. When the rodlike crystals are parallel to the vibration direction of the polarized light, the polarized light is almost totally transmitted.

Because polarizing filters are colorless, they can be used as neutral density filters. Even when polarized light is not present in a scene, polarizing filters can be used to reduce the intensity of light. When two polarizing filters are used, their combined densities can be varied considerably.

In color photography, the only way you can reproduce the sky darker without affecting the other colors in the scene is to use a polarizing filter. You can achieve various effects from light sky to dark sky by rotating the fiter to various positions. You can see this effect by viewing the scene through the viewfinder of a single-lens reflex (SLR) camera or by viewing the scene through the ground glass of a view camera. To see how much reflection control you are getting, rotate the filter as you are viewing the scene.

Getting the maximum effect with a polarizing filter depends on your angle to the subject as well as the rotation of the filter. When the reflection cannot be completely eliminated, try changing your camera angle to the subject. The maximum control of unwanted surface reflections and greatest reduction of light intensity occurs when two polarizing filters are used with their optical grids perpendicular to each other. This arrangement can be either two filters in tandem in front of the camera lens or one filter in front of the light source and another filter in front of the camera lens. You cannot control reflections from bare metal surfaces because the reflected light is not polarized.

SKYLIGHT FILTERS

By absorbing ultraviolet radiation, a skylight (1A) filter adds warmth to a scene recorded on a color transparency film. It does this by reducing the bluish cast prevalent in distant scenes and in scenes photographed on heavily overcast days or in open shade. A skylight filter is used primarily with daylight color reversal film exposed under the above conditions. A skylight filter is light pink in color.

FILTER FACTORS

Filters function by absorbing a portion of the light reflected from the subject to the camera. To compensate for this absorption and the loss of light, you may have to increase the exposure to compensate for the light absorbed by the filter. A numerical value is assigned called a “filter factor” or multiplying factor. This numerical factor is based on several variables that include the color sensitivity of the film, density of the filter, color of the filter, and color temperature of the light source. As these variables change, the filter factor also changes to produce the correct exposure consistently. Filters are often identified as “2 X yellow” or “4 X orange.” That implies that the filter factor is 2 and 4, respectively. Remember, the filter factor does not always remain constant when conditions change.

For example, a blue filter used with panchromatic film exposed with daylight requires a smaller filter factor than when the same film and filter are used with tungsten light. The reason for this is daylight has a higher content of blue light that is readily transmitted by the blue filter. Thus, with the same film and filter combination and with the same camera shutter speed and f/stop, more exposing light is available at the film plane with daylight as compared to tungsten light.

A filter that absorbs a great amount of illumination from a given light source is assigned a larger filter factor. A filter that absorbs a lower amount of illumination from the same light source is assigned a smaller filter factor.

To obtain the necessary light at the film plane for correct exposure with a filter, you must increase the original calculated exposure (without a filter). This increase in exposure is determined with a filter factor. When a filter has a factor greater than 1, an adjustment to the exposure must be made.

There are three general methods of using filter factors to determine the exposure increase required:

1. Divide the ISO speed by the filter factor, and use the product as the effective film speed.

Example: If the filter factor is 2 and the IS0 speed of the film is 100, the effective film speed is 50 (100 + 2 = 50).

Thus setting a film speed of 50 on your light meter produces the equivalent of 1 f/stop of additional exposure.

2. Determine the required exposure without the use of a filter; then multiply the unfiltered shutter speed by the filter factor.

Table 3-6.–Filter Factor Equivalent Exposure Table

Filter factor	Open lens aperture (f/stop)	or if the "unfiltered" shutter speed is									
		1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500	1/1000
2	1	Use a "filtered" shutter speed of									
		1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250	1/500
4	2	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125	1/250
8	3	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60	1/125
16	4	8	4	2	1	1/2	1/4	1/8	1/15	1/30	1/60

Example: The unfiltered exposure calls for l/60 second, and the filter factor is 3. The correct exposure is 1/20 second (1/60 x 3 = 1/20 second). However, most cameras do not have a 1/20 second shutter speed; therefore, use 1/15 second or the next slowest shutter speed.

3. When you are using an SLR camera with through the lens (TTL) metering, put the filter on the camera lens and adjust the exposure in the normal manner. However, certain dark blue, red, and orange filters may give faulty readings if used with TTL metering systems because the meter reads 18 percent gray. The camera light meter may not be sensitive to the color of light passed by the filter.

4. Consult a filter factor equivalent exposure table. (See table 3-6.)

DARKROOM FILTERS

No types of filters are used almost exclusively in the photographic darkroom. They are safelight filters and printing filters. The printing filters include variable contrast filters for printing black-and-white materials and color printing filters for printing color materials.

SAFELIGHT FILTERS

The word *safelight* in photography is used to describe filtered tungsten illumination or direct illumination from a sodium-vapor lamp. The color of a sodium-vapor lamp does not affect (expose) light-sensitive materials under prescribed darkroom conditions. The word *safe* is misleading since light-sensitive materials are never completely safe from safelight illumination. The use of a safelight with some types of light- sensitive materials is not recommended Compatible safelight filters for use with certain light-sensitive materials should be selected on the basis of color sensitivity and emulsion speed of the material. The best method of selecting a darkroom safelight filter is to use the filter recommended by the manufacturer of the light-sensitive material. Safelight filters absorb that portion of the visible spectrum produced by a tungsten lamp that would affect the light-sensitive material being handled.

Sodium-vapor lamp safelights use sodium gas to provide safelight illumination. Incandescent sodium gas produces a very narrow band of visible light in the yellow-orange portion of the spectrum. Colorblind printing papers are not sensitive to this monochromatic (one color) band of light, whereas the human eye is very sensitive to it. Therefore, a brighter print room is possible without the light affecting the printing paper. By using specially designed filters that further reduce the narrow band of sodium-vapor light, black-and-white materials sensitive to green and red light can be handled under this illumination. Table 3-7 provides some examples for the application of safelight filters. Always consult the *Photo-Lab-Index* to determine the best safelight for use with various light-sensitive materials.

VARIABLE CONTRAST PAPER PRINTING FILTERS

To obtain various degrees of contrast using variable contrast printing papers, use a series of magenta and yellow filters. The magenta filters are used to print black-and-white negatives that are low in contrast.

Table 3-7.–Safelight Filters

Filter Designation	Color	Use With
OA	Greenish Yellow	Black-and-white contact and duplicating materials and projection films
OC	Light Amber	Printing papers
No. 1	Red	Blue sensitive films
No. 1A	Light Red	Orthochromatic copy films
No. 2	Dark Red	Orthochromatic films
*No. 3	Dark Green	Panchromatic films

NOTE

*Use caution when processing panchromatic film under a No. 3 safelight. When a No. 3 safelight is used, the film should not be exposed to it until at least half of the developing time has passed. Then the film should be examined quickly at a distance of about 36 inches from the safelight. Much experience is needed to judge proper negative development by the process of inspection, and it is rarely performed.

Yellow filters are used to print black-and-white negatives that are high in contrast. Variable contrast printing filters are discussed in chapter 10 of this TRAMAN.

FILTERS FOR COLOR PRINTING

Filters used to print color are as follows: color compensating (CC), color printing (CP), ultraviolet absorbing, and dichroic. Each one of these filters is discussed below.

Color Compensating Filters

The color compensating filters used for printing color materials are the same CC filters used with color film. These filters are used to modify the color quality of the exposing light needed to print the color negatives or transparencies. CC filters are used between the lens and the paper in the color printing process. These CC filters are referred to as a filter pack

CC filters control the color of light that strikes the emulsion. They control the amount of light each emulsion layer receives during exposure. That results in the amount of color dyes formed in each emulsion layer. The overlapped colored dyes (cyan, magenta, and yellow in proper proportions) represent the colors of the original scene.

Color Printing Filters

Color printing (CP) filters are used in color printing, the same as CC filters with one exception. CP filters are placed in the enlarger between the light source and the negative or transparency being printed. That is done because CP filters are made of acetate and affect image definition.

CP filters are available in red, cyan, magenta, and yellow with densities of 0.05, 0.10, 0.20, and 0.40. The color of a filter and its peak density are identified the same as CC filters.

Ultraviolet Absorbing Filters

Ultraviolet absorbing filters for color printing prevent the fogging of the color material by ultraviolet radiation emitted by the exposing light source. This filter is not considered part of a printing filter pack, but it is always present in color printing systems. An ultraviolet absorbing filter for color printing is identified as 2B.

Dichroic Filters

Most photographic filters use colored dyes that absorb certain wavelengths and allow others to be transmitted. Such filters do not begin and end transmission at precise wavelengths.

Sharp-cutting, narrow-band filters are produced using wavelength interference rather than wavelength absorption. Dichroic or interference filters pass certain precise wavelengths and reflect all others.

Dichroic filters are used extensively in color printing and photographic testing systems. Because of their stability and long life, dichroic filters provide more accurate and more precise filtration.

HANDLING AND STORING OF FILTERS

A gelatin filter is protected by a thin lacquer coating that provides little protection against careless handling. Handle these filters carefully and only the edges. When not in use, gelatin filters should be stored in their original package, or they can be stored in clean paper between pages of a book. Gelatin filters should be kept flat and stored in a dark, dry place. Continued stress on gelatin filters can deform them permanently. When stored in high-humidity areas, they can become cloudy.

Dust particles should be removed from gelatin filters by brushing gently with a clean camel-hair brush or by clean, low-pressure air.

Glass filters or gelatin filters mounted between glass should be treated the same as photographic lenses. They should be kept in protective boxes or containers and should never be exposed to dampness or dirt. Never wash glass-mounted filters with water. When water comes in contact with the gelatin at the edges of a glass-mounted filter, it causes it to swell and allow air to enter between the gelatin and the glass. That causes a defect in the optical properties of the filter.

When a glass-mounted filter becomes dirty, you should not rub or breath on it. Use a piece of soft cloth or lens tissue moistened with lens cleaner. Do not allow the lens cleaner to touch the edges of the filter. Large pieces of grit should be removed with a camel's hair brush before attempting to clean the filter.

Do not expose gelatin or glass filters to temperatures higher than 122°F (50°C). High temperatures, high humidity, and time affect the stability of the dyes and shorten the life of the filter.

You should now have a basic understanding of filters and how they affect various wavelengths of tight. You should know the ways in which filters are used for exposing light-sensitive materials. Filters are an integral link to high-quality products. This knowledge provides you with an invaluable tool in filter application for all the various stages of the photographic processes.

CHAPTER 4

STILL CAMERAS AND CONTROLS

Cameras have gone through many changes in design over the years. Several of your chiefs and division officers remember lugging around bulky, cumbersome 4x5 Speed Graphic cameras with film holders and tripods just to cover routine assignments. Through the development of modern-day cameras and film, small, hand-held cameras are commonly used. A large variety of cameras are available in the imaging facilities of the Navy. After learning the nature of your assignment and the equipment available, you must choose the equipment that will get the job done best, whether it be a 4x5 view camera or a small, hand-held electronic camera.

The human eye may be compared to a camera There are several similarities. The eye is a physiological optical instrument. The camera is a mechanical optical instrument. The eye has a lens, and like the lens of a camera, it forms an image on a light-sensitive surface (fig. 4-1). The lens of the eye focuses light on the retina. The camera lens focuses light on the film plane. The lens of the eye focuses by changing its curvature, the camera lens by changing its focal length. The diaphragm on a camera is similar, like the iris of the eye. When the light is bright, the iris closes down, reducing the brightness of the image. Likewise, when the light is bright, the camera diaphragm closes down When the light is dim, the diaphragm opens up. The components of the eye are held together by the sclera, the components of the camera by the camera body.

A camera in its simplest form (fig. 4-2) is a lighttight box with a lens to form an image, a shutter to control the length of time light is allowed to act on the film, a

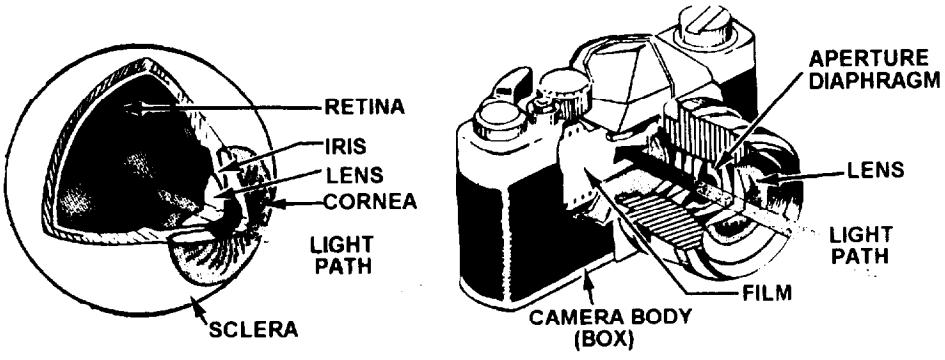


Figure 4-1.–Comparison of human eye to a camera.

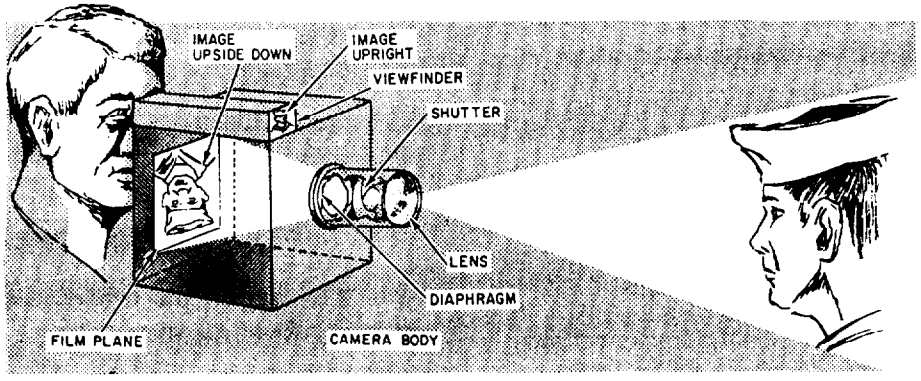
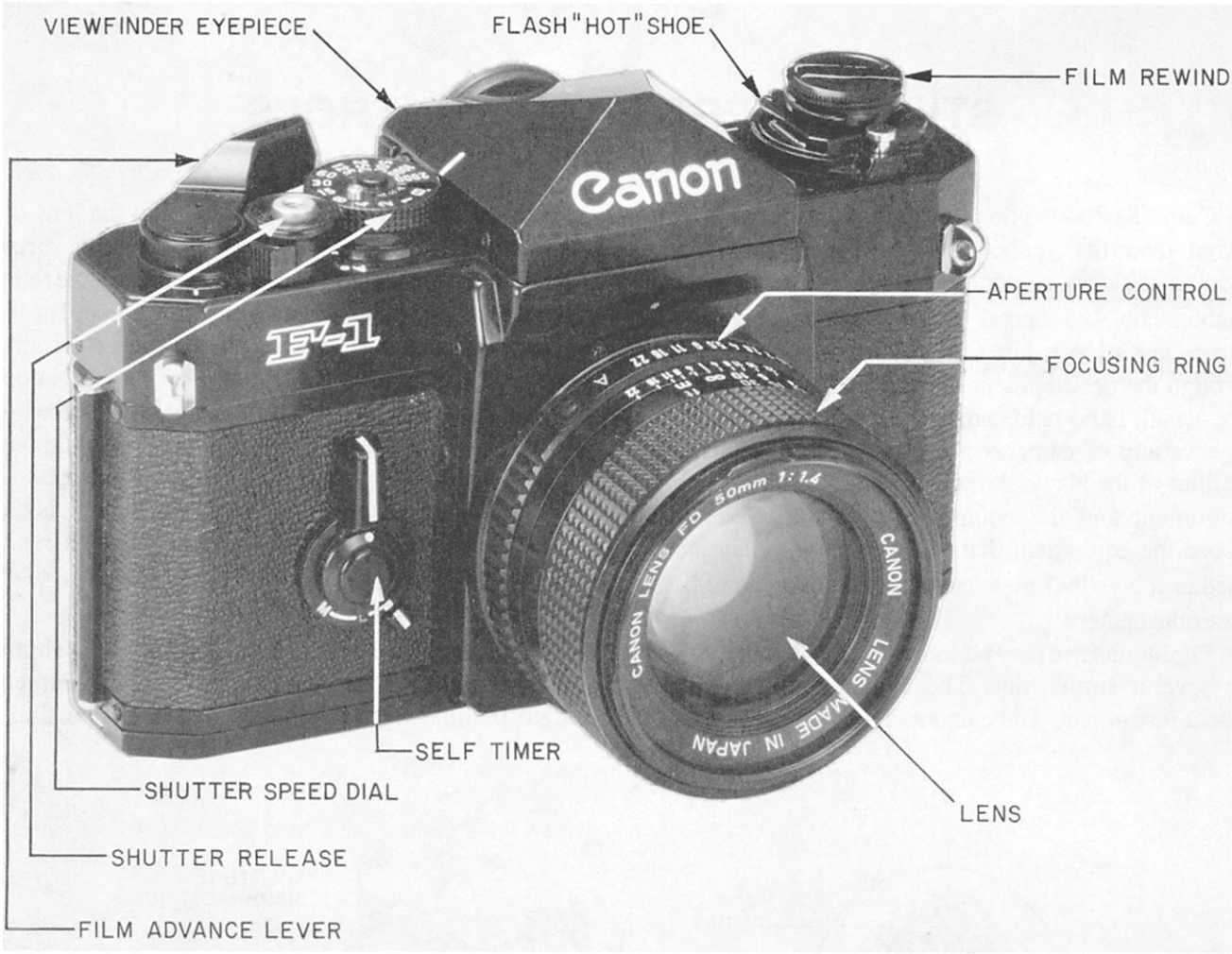


Figure 4-2.–A simple camera.



R. B. Burrows
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Figure 4-3.–35mm single-lens reflex (SLR) camera.

diaphragm to control the brightness of the image, a means of holding the film at the back of the camera, and a viewfinder so the photographer knows what the image is, and of course a body to hold it all together.

Simple cameras, such as the one described, have limited capabilities. They have a fixed-focus lens that cannot produce a sharp image of a subject closer than about 6 feet. Also, the shutter speed and diaphragm are preset and cannot be altered. The capabilities of a simple camera can be enhanced by adding features to perform the following:

- Focus on subjects at various distances
- Adjust the lens for different lighting conditions
- Change various lenses quickly to change focal length and fields of view
- Change shutter speed to "capture" images of moving subjects
- Use synchronized electronic flash
- Meter the image brightness of the subject to either manually or automatically adjust the diaphragm and shutter speed

Figure 4-3 illustrates a common 35mm camera and identifies the various camera controls.

CAMERA TYPES

In this chapter, the characteristics and functions commonly found on most cameras are discussed. No single camera can meet the requirements of every photographic assignment. There are a number of cameras to choose from in the fleet. These cameras

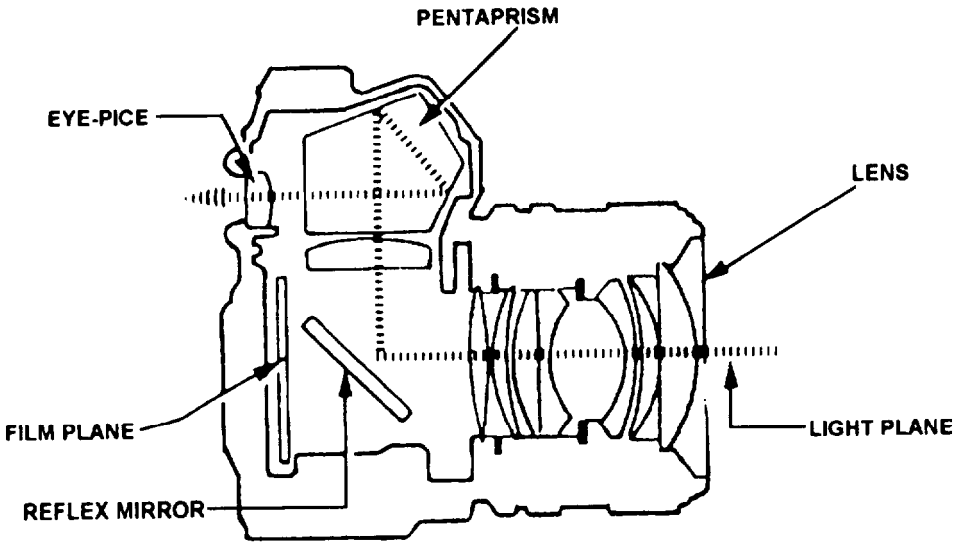


Figure 4-4.–Design of a typical SLR camera.

produce negatives that range in size from 35mm to 8x10 inches. You will learn to choose the camera that best meets the conditions of your assignment and the customer's photographic requirements.

The number and types of cameras available at an imaging facility depend primarily on the mission of the facility. All cameras have common features. Once you become familiar with the operation of one camera, you can learn quickly to operate other types. There are three general categories of cameras: small format, medium format, and large format.

SMALL-FORMAT CAMERAS

Cameras that produce negatives smaller than 35mm are considered small-format cameras. Small-format cameras are preferable when you need maximum freedom of movement and a large number of negatives without reloading the camera. The accessories, lenses, and flash equipment can be carried easily, and commonly 36 frames may be taken rapidly without reloading the film. This type of camera is helpful for news and action photography where several pictures must be taken in a short time from various ranges and under varying light conditions. The primary disadvantage of small-format cameras is they produce small negatives. The smaller the negative, the more it must be enlarged in printing.

The most popular professional small-format camera is the 35mm single-lens reflex (SLR). This camera has a mirror in the path of the image formed by the lens that is reflected to a viewing screen for focusing and composition. This allows you to see what the lens sees regardless of the lens focal length or the lens-to-subject distance. The reflex system is simple and reliable. It has three main elements: a hinged mirror, a matte focusing screen, and a five-sided glass prism called a pentaprism The mirror, in the viewing position, is below the viewing screen and behind the lens. It is at a 45-degree angle and projects the image formed by the lens up to the focusing or viewing screen. The pentaprism reflects the image from the focusing screen, so you can see it in the camera eyepiece. Figure 4-4 shows the design of a typical SLR camera.

When the shutter release is pressed, the mirror swings up and out of the light path, so the light can reach the film. It also seals off the viewfinder, so light entering the eyepiece cannot reach the film. After the film is exposed, the mirror swings back down, and the image is visible again in the viewfinder.

CAUTION

The reflex mirror is thin glass coated on the front with silver, so care must be taken not to damage it by touching or scratching it. Follow only the procedures listed in the Planned Maintenance System (PMS) for cleaning camera mirrors.

Almost all 35mm cameras have focal-plane shutters. Focal-plane shutters simplify the construction of the camera and make interchangeable lenses smaller,

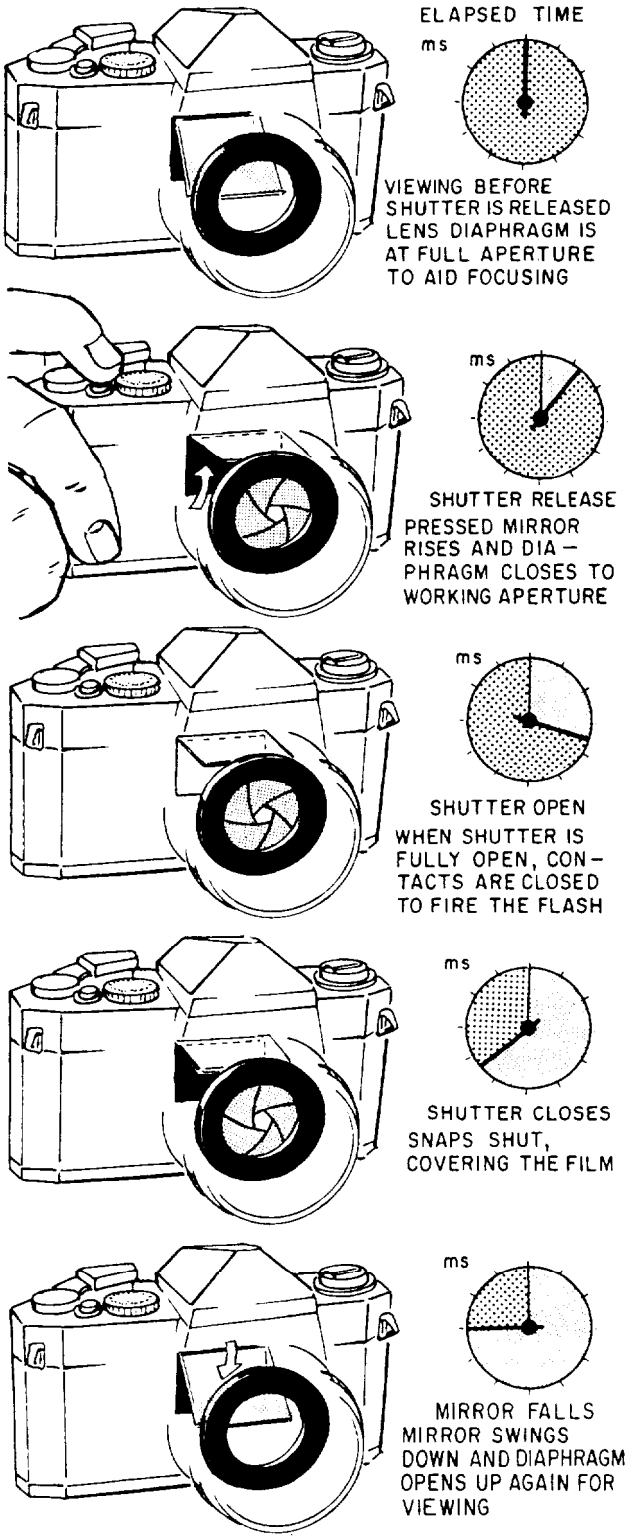


Figure 4-5.–The shutter, aperture, and mirror operate in a precke sequence when exposures are made.

lighter, and less expensive. The shutter, aperture, and mirror work together in a precise sequence that is repeated each time the shutter is tripped (fig. 4-5).

Most SLR lenses have an iris diaphragm. The diaphragm is held wide open for focusing and viewing. The aperture is then stopped down automatically to the preset working aperture at the instant the exposure is made. That means the image on the viewing screen is bright, easy to see, and focus; but only controlled brightness reaches the film for exposure.

Focusing is done by turning the lens focusing ring. A screw thread that runs around the inside of the lens barrel moves the lens closer or farther away from the film as the focusing ring is turned. The interchangeable lenses of most 35mm cameras are attached by a bayonet flange. Each lens mount differs slightly for each manufacturer of lenses and cameras, thus different lenses and camera bodies cannot be interchanged.

Most 35mm SLRs have a built-in light meter that reads through the lens (TTL). The light meter may read the light falling on the mirror, the shutter curtain, the focusing screen, or even on the film at the instant of exposure. On an automatic camera, the f/stop or shutter speed is adjusted automatically for correct exposures. On manual cameras, the light meter produces a display in the viewfinder to indicate the correct camera settings. You must then set the camera controls to get the correct exposures.

MEDIUM-FORMAT CAMERAS

Medium-format cameras are very popular in Navy imaging facilities. Except for the increased size, these cameras are just as versatile as small-format cameras. Interchangeable lenses, TTL metering, SLR focusing systems, and both manual and automatic controls are available on medium-format cameras. The advantage of a medium-format camera is the larger negative size of 120 or 220 film. These cameras are commonly used for portraiture or when relatively large prints are required from the negative. The most common medium-format camera used by Navy imaging facilities is the Bronica ETRS (fig. 4-6). This camera is available in almost all Navy imaging facilities, both afloat and ashore.

LARGE-FORMAT CAMERAS

Large-format cameras are used when you must retain maximum detail in the negative. This is necessary when certain subjects are photographed to exact scale or when large prints are required. Large-format cameras produce negatives 4x5 or larger. The most common large-format cameras are view cameras and copy cameras. Features common to all large-format cameras are as follows:

- Ground glass viewing and focusing



Courtesy of Tamron Industries, Inc.
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Figure 4-6.–Bronica ETRS medium-format camera.

- Both front and rear focusing
- Bellows that extend to permit at least a 1:1 image ratio

In addition to the features listed above, the view camera has additional features that control image sharpness and distortion. The view camera is discussed later in this chapter.

CAMERA CONTROLS

When you take a picture, the camera causes light reflected from the subject to be imaged on light-sensitive material. The camera controls this action in several ways. The first control is focus. Cameras have components to show what part of the scene will be recorded in sharp focus on the film. For example, some cameras use a coincidence or split-image range finder, and others use a focusing screen or ground glass.

The second camera control is the **lens aperture.** This control is located next to the focusing ring on most cameras. As discussed in chapter 1, the aperture affects both focus and exposure.

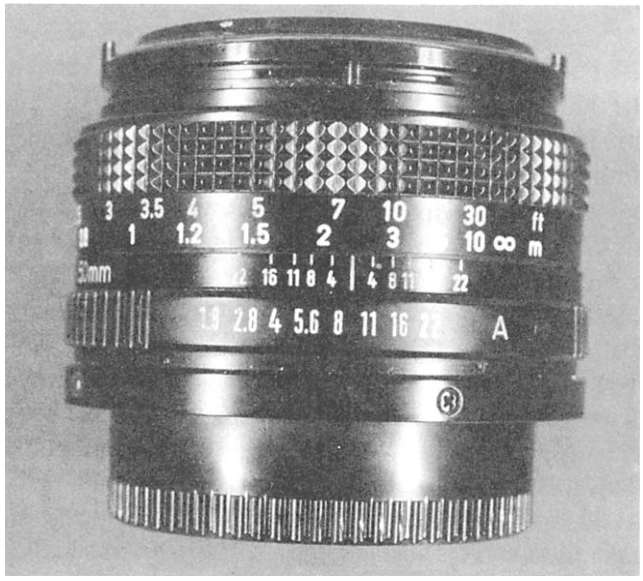
The third control is **shutter speed.** The shutter controls the length of time light is admitted to the film. Shutter speed also has an effect on the way movement is recorded on film.

FOCUS

Focusing involves adjusting the distance between the lens and the focal plane, or film plane, when photographing subjects at various camera-to-subject distances. When a camera lens is focused on a subject point, all light rays from that point, and only that point, are brought to sharp focus at the film plane. When about 600 or more feet from the camera, the subject is considered to be at infinity. A subject at infinity is so far from the camera that rays of light reflected to the lens from the subject are considered parallel. When a camera is focused on a subject at infinity, the distance between the optical center of the lens and the film plane (lens-to-film distance) is equal to the lens focal length. At this point the lens is closest to the film plane. As the camera-to-subject distance decreases, the lens-to-film distance must be increased to bring the subject into focus.

When you are taking a picture of only one subject, focusing is simple; however, when you want to include several subjects at different distances from the camera in the same picture and have them all in sharp focus, it becomes more complicated. Unless the subject is distant scenery with nothing in the foreground, there is always one object that is closer to the camera than another. Then you must decide what part of the scene is to appear in sharp focus. In simple cases, such as a sailor standing against a plain background, the decision is simple-focus on the sailor. In more complex cases, when subjects both close and far from the camera must be in sharp focus, you should focus about one third of the distance into the scene. In other words, focus about one third of the distance between the closest and farthest subject you want in sharp focus. This is known as the **depth of field.**

The way you focus the camera will depend on what part of the picture is most important and its purpose; for example, the pictures a civil engineer needs of a building at a naval air station is altogether different from the pictures a visitor to the air station wants to take home. The engineer needs pictures that show a maximum amount of detail throughout the scene. The visitor, on the other hand, is more interested in pictures that bring back pleasant memories. The requirements of the picture determine what you should focus on. The engineer needs to have everything in the picture in sharp focus. You might accomplish this as follows: Measure the distance to the nearest point of the picture and the distance to the farthest part of the scene. Then consult the depth-of-field scale on the camera lens to focus on a point between these two distances. Now, when the lens is stopped down to a small aperture, the depth of field is



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Figure 4-7.–Focusing scale.

increased. Both near and far points will appear in focus. In photographing the scene for a visitor, you may want to emphasize only the entrance way to the building, rather than concentrating on getting everything in the picture in sharp focus.

Focusing Systems

Accurate focusing and framing are essential to good pictures, and modern cameras have many devices to help you get good focusing and framing results.

Because of the principles of depth of field, simple cameras are manufactured without any way of adjusting focus. The lenses of these simple cameras are prefocused at the hyperfocal distance. Remember from chapter 1, that the hyperfocal distance for a lens is determined by the focal length and the aperture. That allows "point and shoot," ID, and passport cameras to produce pictures where everything from about one half of the hyperfocal distance through infinity are acceptably sharp.

Focusing is accomplished by adjusting the distance from the lens to the film. It does not matter which of the two is actually moved, the lens or the film. With hand-held cameras the lens is moved in and out. Usually on large-copy cameras, the camera back (film plane) is moved toward or away from the lens, That is because the distance from the photographer to the lens board is usually too great to focus through the ground glass.

No matter what system you use to focus the camera, there must be a means for you to determine when the image is in focus. Some cameras have autofocusing systems. Most camera systems used by Navy personnel are focused manually.

Focusing Scale

This is the simplest type of focusing system. It uses a scale of distances that indicates the distance where the focus is set. Primarily, these scales are engraved on the lens barrel. To use the focusing scale, you can measure the camera-to-subject distance, but, in most cases, you must estimate the camera-to-subject distance. This distance is then set to the focus index mark on the lens (fig. 4-7). Scale focusing can be useful when you anticipate quick action but do not have sufficient time to focus the camera. When using scale focusing, a small f/stop is helpful so you can rely on depth of field to provide an acceptably sharp image.

Ground Glass Focusing

With some cameras, focusing is done by viewing the image on a glass screen, called a ground glass. The image formed by a view camera is projected directly to the ground glass for viewing and focusing. Accurate focusing can be achieved using a ground glass. There is a drawback to this type of focusing. Because of the texture of the ground glass, very fine detail of the image is difficult to distinguish. That results in some leeway in focusing. Additionally, when you work too long at focusing the image, your eye will adjust and accept an image that is less than sharp. For this reason, it is helpful to place a magnifying loop directly on the ground glass. That helps in focusing quickly and accurately.

A ground glass focusing system shows directly the image that will appear on the film. The image size and depth of field records on the film the same as it appears on the ground glass. Ground glass focusing systems are commonly found on copy cameras and view cameras. The image on the ground glass appears upside down and backwards.

Reflex Focusing

A reflex focusing system also uses a ground glass or focusing screen; however, instead of the image being

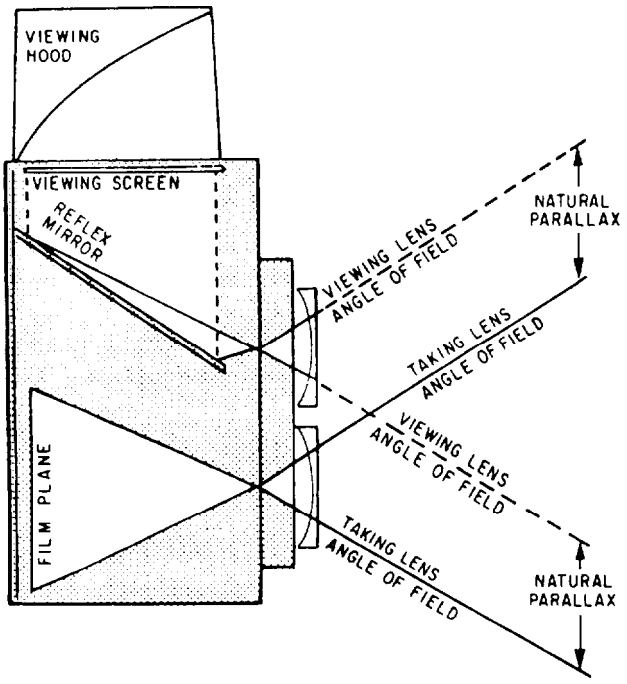


Figure 4-8.–Twin-lens reflex camera.

formed directly on the ground glass or focusing screen, the lens forms the image on a mirror that reflects the image to the focusing screen or ground glass.

TWIN-LENS REFLEX.–The twin-lens reflex (TLR) system uses a matched set of lenses for focusing and viewing. One lens is the viewing lens; the other is the picture-taking lens. The viewing lens is always wide open. That makes focusing and viewing easy, but depth of field cannot be viewed. Depth of field must be determined by a scale that is provided on the lens or camera body.

An advantage of the twin-lens reflex system is that the image is visible on the focusing screen, before, during, and after exposure. A disadvantage of twin-lens systems is that parallax errors occur. Parallax refers to the difference between the image seen through the viewing lens and the image transmitted to the picture-taking lens (fig. 4-8). For distant subjects the difference is not very great or noticeable; however, when your subject is close to the camera, parallax is much more noticeable. You see a different image area through the viewing lens than what is being transmitted through the picture-taking lens. Some twin-lens reflex cameras have an indicator in the viewing lens, so you can compensate for parallax. Another disadvantage of the twin-lens reflex camera is that it takes practice to

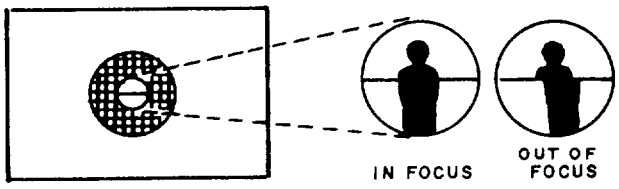


Figure 4-9.–Split-image focusing.

follow action and compose the subject. The image seen on the focusing screen is backwards from the actual image. Twin-lens reflex cameras are no longer commonly used in Navy imaging, but they are still around.

SINGLE-LENS REFLEX.–Single-lens reflex (SLR) cameras have a focusing and viewing system that shows you the image formed by the picture-taking lens. SLR cameras are designed so the distance between the focusing screen and the lens is exactly the same as the distance between the lens and the film; therefore, whatever appears in focus on the focusing screen will also be recorded in focus on the film. With an SLR camera, there is no parallax error.

Sometimes two small prisms or a split screen is included in the central area of an SLR camera viewing screen. When the image is out of focus, it appears split in this area (fig. 4-9). Some screens have a central grid of minute prisms that produce a shimmering effect when the image is out of focus.

An SLR camera is focused by rotating the focusing ring on the lens until the image seen through the viewfinder is in sharp focus. SLR cameras are the most commonly used camera in Navy imaging today.

Direct-Vision Range Finder Focusing

Cameras that use direct-vision range finder focusing produce a double image in the viewfinder until the subject is in focus on the film plane. This system has a coupled range finder optical device that is linked to the focusing ring. To focus a direct-vision coincidence or split-image range finder camera, you must align two separate images of the subject. When looking through the camera viewfinder, you see a pale or tinted area in the center of the viewing window. This area shows the double image. To set the correct focus, you aim the camera so the subject you want in sharpest focus is in the pale area. You then turn the lens focus ring, or camera

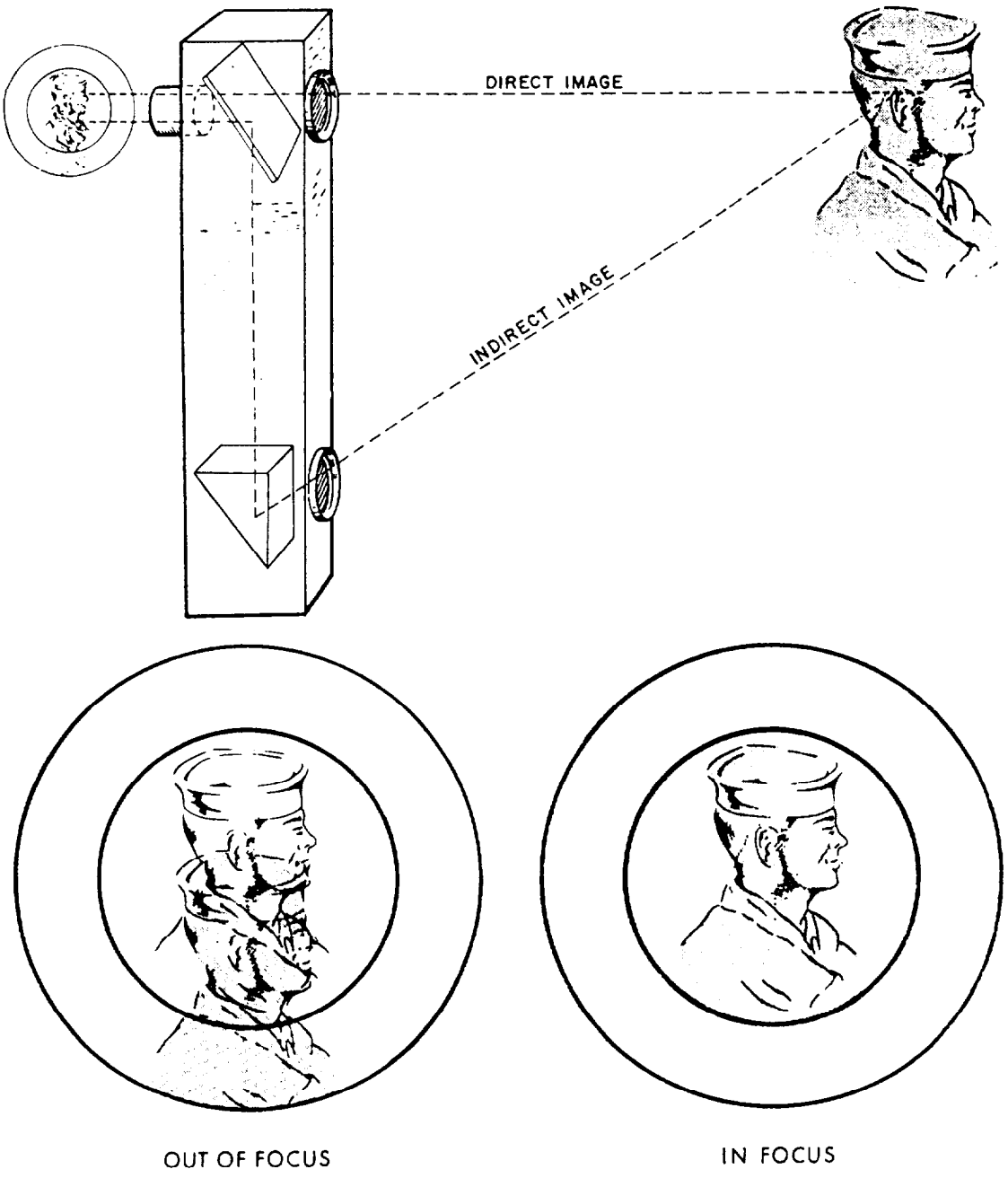


Figure 4-10.–Direct-vision range finder focusing.

focus knob, until the double images coincide and only one image is seen (fig. 4-10).

The disadvantages of a direct range finder system are that it does not couple to a large variety of lenses, thus restricting its use to only several different focal-length lenses. Unlike the ground glass and SLR focusing systems, depth of field cannot be determined in the direct-vision range finder system. Everything appears sharp through the viewfinder window.

Autofocus

Most autofocus cameras use the same principle as a direct-vision range finder camera. The autofocus camera determines the subject distance by comparing



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Figure 4-11.–Use of selective focus.

the contrast brightness of two images: one reflected from a fixed mirror, the other from a movable mirror. This system works on the theory that the sharpest images have the highest contrast. When maximum contrast is reached, an electronic device converts the contrast brightness information into impulses. These impulses start a motor that moves the lens to the point of sharp focus. This type of autofocus system does not perform effectively when the subject is all one color or does not contain much contrast.

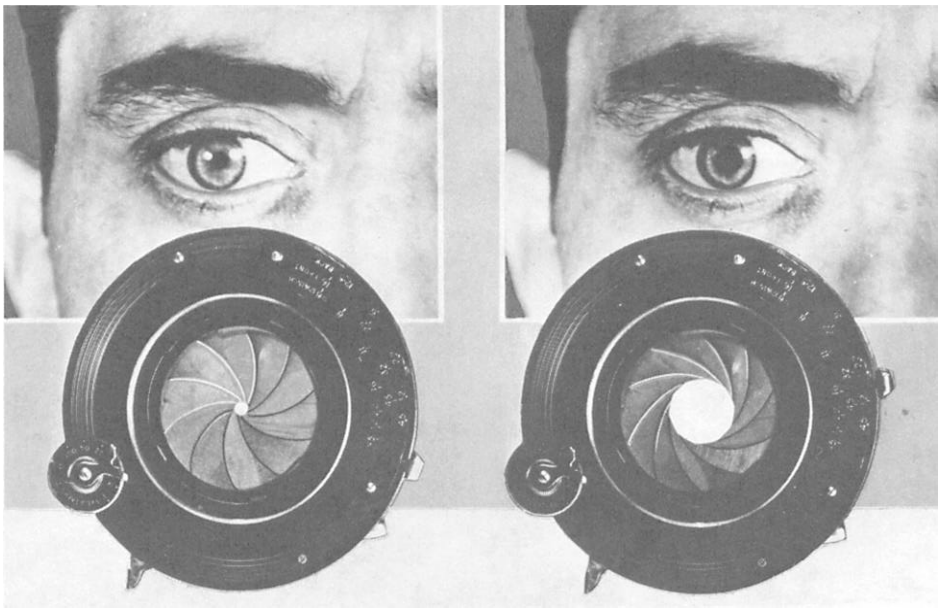
Another type of autofocus camera uses sonar or infrared These systems emit either a sonar or infrared signal to determine subject distance. The distance is determined by the amount of time it takes the transmitted energy to reflect back from the subject to a sensor on the camera. This information is then sent to a motor that moves the lens to the point of sharp focus. The sonar autofocus system has a disadvantage. You cannot photograph subjects through glass. The sonar reflects off the glass and not the subject.

SELECTIVE FOCUS

You do not always want everything in your photographs to be in sharp focus. By using selective focus, you can emphasize the main subject and draw attention to it. "Selective focus" means the use of a shallow depth of field to isolate or emphasize the subject (fig. 4-11). Selective focus is the control of the zone of sharpness, or depth of field, in your photographs.

Once the lens has been focused on the main subject of the picture, using a progressively larger aperture (f/stop) will reduce the zone in front of and behind the subject that is in focus. Long-focal-length lenses are more effective for selective focusing because of their larger real apertures. Wide-angle or short-focal-length lenses are not as effective for selective focus because of the great depth of field they provide at most apertures. The following factors provide the maximum selective focus control by minimizing depth of field:

- Working close-up
- Using a wide aperture



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Figure 4-12.–Iris diaphragm.

- Using a long-focal-length lens
- Focusing on near objects

APERTURE

The aperture, or f/stop as it is commonly called, is used to regulate the diameter of the lens opening. That controls the luminance on the film plane. Besides controlling the luminance on the film plane, the f/stop also controls image sharpness by partially correcting various lens aberrations.

The most commonly used aperture control device is the iris diaphragm. An iris diaphragm is an adjustable device that is fitted into the barrel of the lens or shutter housing. It is called an iris diaphragm because it resembles the iris in the human eye (fig. 4-12). An iris diaphragm is a series of thin, curved, metal blades that overlap each other and is fastened to a ring on the lens barrel or shutter housing. The size of the aperture is changed by turning the aperture control ring. The blades move in unison as the control ring is moved, forming an aperture of any desired size. The control ring is marked in a series of f/stops that relate to the iris opening. The aperture controls the **intensity** of light that is allowed to pass to the film and the parts of the image that will appear in sharp focus.

Depth of Field

Depth of field is that zone both in front of and behind your subject that are in acceptably sharp focus. The focusing controls on most cameras are easy to use, providing you understand the factors that effect depth of field. To produce professional quality photographs, you must know how to control the depth of field.

Aperture, or f/stop, is the most important factor in controlling the depth of field. The smaller the f/stop opening, the greater the depth of field; for example, at f/16, a normal lens focused on a subject 16 feet from the camera may show everything in focus from 8 feet to infinity. At f/5.6, depth of field may range from about 3 feet in front of the subject to about 6 feet behind the subject. At f/2, only the subject focused on is sharp. As shown in figure 4-3, a shallow depth of field results in a blurry foreground and background, whereas greater depth of field results in more overall sharpness.

Camera-to-subject distance also has an effect on the depth of field. In general, the closer you are to the subject, the shallower the depth of field. Even at f/16 with a normal lens, if you focus on a subject only 3 feet from the camera, the depth of field may only be about 1 foot. At f/2, the subject's eyes may be in sharp focus, but the nose and ears are blurred. As you increase the camera-to-subject distance, the depth of field increases rapidly. Using an aperture of f/16 and focusing at 6 feet, the depth of field may extend from a foot in front of the subject to about 3 feet in back of the subject. Still using

Table 4-1.–How to Control Depth of Field

If you want less	If you want more
Use a larger f/stop (lower number).	Use a smaller f/stop (higher number).
Use a longer focal length lens.	Use a shorter focal length lens.
Move closer to the subject.	Back up from the subject.
Use a filter to reduce the amount of light allowed to be transmitted and use a larger f/stop.	Use a faster film or a slower shutter speed and use a smaller f/stop.
	Focus at the hyperfocal distance.

f/16 but focusing now at about 16 feet, the depth of field is almost at infinity. Most normal lenses for 35mm cameras produce these maximum ranges of sharpness at about 16 feet. Focusing any farther from the camera only reduces foreground sharpness. You must remember this point when attempting to get the greatest possible depth of field.

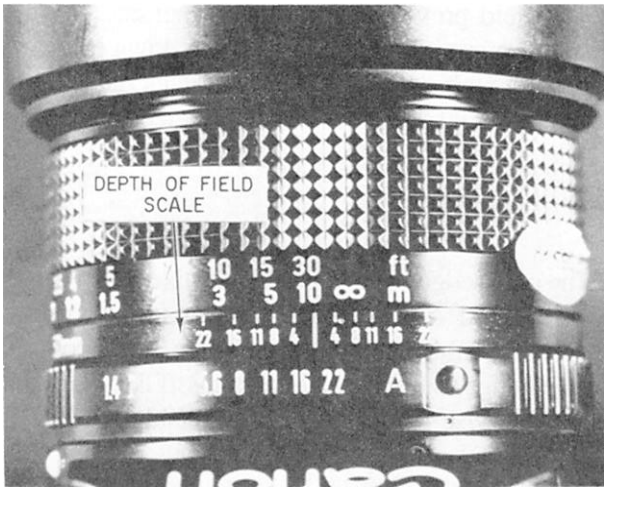
Lens focal length is also a factor in depth of field. The shorter the lens focal length, the greater the depth of field at a given aperture. In other words, a wide-angle lens provides more depth of field at f/8 than a normal lens, and a normal lens provides more depth of field at f/8 than a telephoto lens.

You know that a small aperture like f/16 provides more depth of field than a wide aperture like f/2. With experience, you can predict the best aperture for the depth of field desired. Even with experience, you do not always have to guess the aperture setting or calculate the hyperfocal distance, near distance, and far distance by using formulas. Most lenses have a depth-of-field scale to guide you (fig. 4-13). The depth-of-field scale indicates the distance range from the camera that the subject(s) appear in acceptably sharp focus. The depth of field on an SLR is marked between the aperture ring and the focusing scale. Use the depth-of-field scale as follows:

1. Focus on the subject.
2. Select the f/stop.
3. Look at the depth-of-field scale and locate the marks that correspond to your chosen f/stop. The f/stop appears twice, once on either side of the scale center line.
4. Read the two distances on the focusing scale that are adjacent to the two f/stops on the depth-of-field scale. You may have to estimate the distances.

You can see in figure 4-13 that the lens is focused at a distance of 30 feet with the aperture set between f/16 and f/22. You can see from the depth-of-field scale that the depth of field extends from approximately 11 feet to beyond infinity. If the aperture is opened up to f/8, the depth of field will range from about 16 feet to infinity.

At any given aperture, depth of field is maximized by focusing the lens at the hyperfocal distance. That is the closest point of acceptable sharp focus shown on the depth-of-field scale when the lens is focused at infinity. When you are changing the focus setting to the hyperfocal distance, the zone in front of the subject that is sharp is increased, and infinity is still the farthest point



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Figure 4-13.–Depth-of-field scale.



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Figure 4-14.–When the lens is focused at 20 feet and set at f/22, the depth of field ranges from about 10 feet to infinity

in sharp focus. In figure 4-14, when the lens is set at f/22 and focused at infinity, the depth of field ranges from about 20 feet (the hyperfocal distance) to infinity; however, when you change the lens focus to 20 feet, the depth of field ranges from about 10 feet to infinity.

The lenses of modern SLR cameras stay at their maximum aperture until the shutter is tripped. These lenses provide a bright image in the viewfinder to focus. As a result, when you look through the viewfinder, you only see the depth of field for the maximum aperture and not the working f/stop. Most SLR cameras have a depth-of-field preview button to compensate for this. When you press it, the aperture closes down to the set f/stop. Although the viewfinder becomes darker, you can see the actual depth of field at the selected aperture.

Image Sharpness

The outer edges of a lens are least likely to produce a well-defined or aberration-free image; therefore, proper use of the diaphragm, aperture, or f/stop can improve image sharpness by blocking off light rays that would otherwise pass through the outside edges of a lens.

There is a limit to how far the aperture can be stopped down and still increase image sharpness. When the aperture is very small, it causes diffraction of light rays striking the edge of the diaphragm. Diffraction results in a loss of image sharpness. This loss of image sharpness is especially noticeable in copy work

Physical limitations in the design of lenses make it impossible to manufacture a lens of uniform quality from the center to the edges; therefore, to obtain the best quality with most lenses, you can eliminate the edges of the lens from being used by closing down the aperture about two f/stops from wide open This recommended adjustment is called the **optimum** or **critical aperture.** The optimum aperture for a particular lens refers to the f/stop that renders the best image definition.

When a lens is stopped down below the optimum aperture, there is an actual decrease in overall image sharpness due to diffraction. Although the depth of field increases when a lens is stopped down below the optimum aperture, image sharpness decreases; therefore, increased depth of field should not be confused with image sharpness. For example, the image formed by a pinhole camera has extraordinary depth of field but lacks image sharpness. When the lens aperture is closed down to the size of a pinhole, it behaves like one. This is an important factor for subjects in a flat plane (such as copying) where depth of field is not needed.

SHUTTER

A camera shutter controls both the exact instant when the film is exposed to light and the duration of that exposure. The shutter is used in conjunction with the diaphragm to control the exposure of the film. The most important function of the shutter is that it limits the time that light is allowed to pass through the lens and act on the film. There are two types of camera shutters: leaf and focal plane.

Leaf Shutter

The blades of this type of shutter are usually located between or near the lens elements and close to the diaphragm. It is sometimes called a between-the-lens shutter; however, a more correct term for this type of shutter is a leaf or diaphragm shutter.

Leaf shutters have several blades made of thin spring steel. When the shutter is closed, these blades, or leaves, are at rest and overlap each other. This prevents light from reaching the film. When the shutter release button is pressed, the blades move apart or open quickly and allow light to pass and expose the film. They remain open for the duration of the preset exposure time before springing shut again (fig. 4-15).

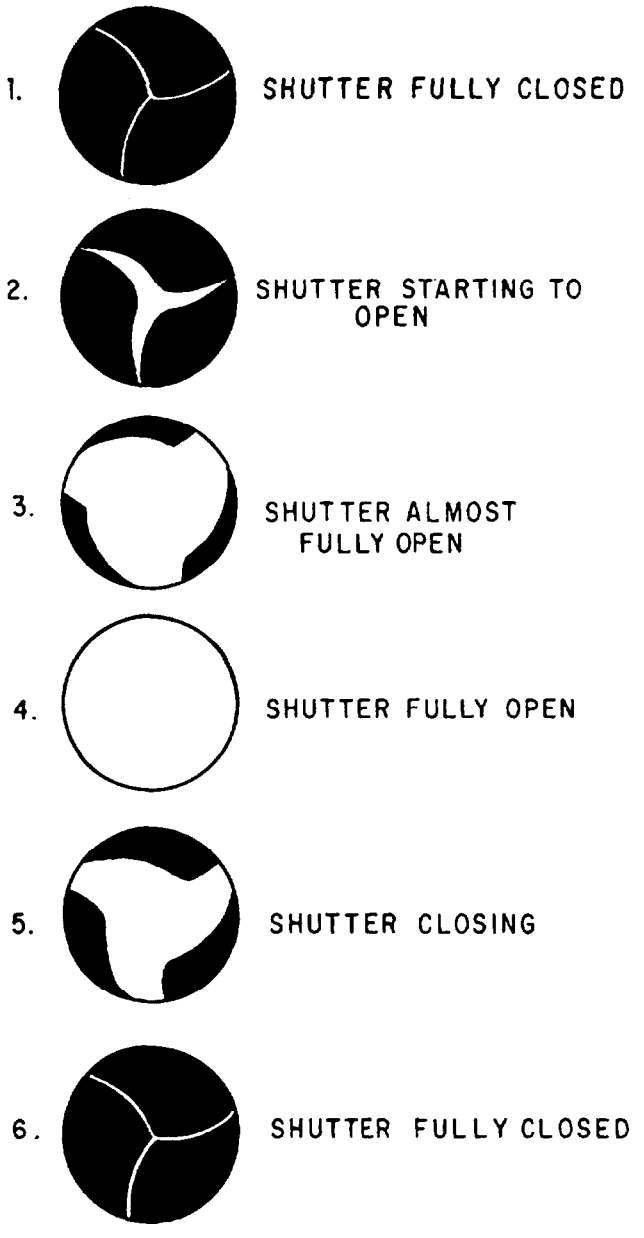


Figure 4-15.–Leaf shutter operation.

Leaf shutters have an important advantage over focal-plane shutters. Leaf shutters can be used with electronic flash at all shutter speeds. This is not true with focal-plane shutters. Focal-plane shutters can only be used at slow shutter speeds, usually at 1/125 second and below.

Focal-Plane Shutter

A focal-plane shutter is essentially two lightproof cloths or thin metal curtains that move across the film aperture in the same direction. This type of shutter is housed entirely within the camera body and is mounted on two rollers, one on each side of the film aperture

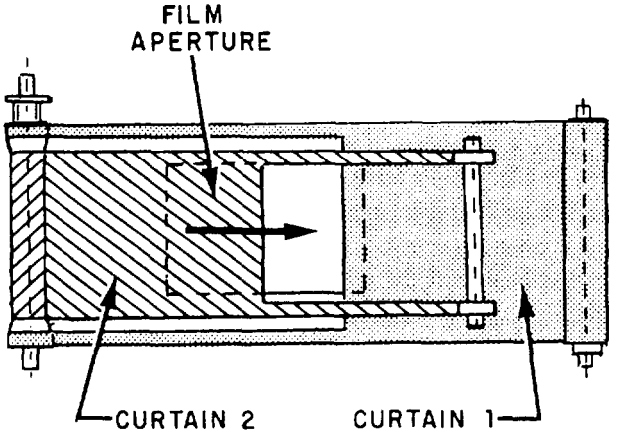


Figure 4-16.–Focal-plane shutter.

(fig. 4-16). As the curtain is moved from one roller to the other by spring tension, the second curtain follows, forming an opening that permits light to pass from the lens to the film. After the opening has passed, the second curtain stops and prevents additional light from reaching the film. In the design of focal-plane shutters, the curtains form a slit that travels across the film aperture to expose the film. When a slow shutter speed is set, the second curtain waits a relatively long time before it follows the first curtain; in this case, the slit is quite wide. When a fast shutter speed is set, the second curtain quickly follows the first and only a narrow slit is formed.

Shutter Speed

A range of shutter speeds is available on professional cameras. Common shutter settings are as follows: T, B, 1 second, 1/2, 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000, and 1/2000 second. The fastest between-the-lens (leaf) shutter speed is 1/500 second. Some focal-plane shutters can be as fast as 1/12000 second. In addition to a given set range of speeds, most shutters are made so they can be opened for an indefinite period of time. At the setting marked "T" (time), the shutter opens the first time the shutter release button is depressed and remains open until the shutter release button is depressed again. At the setting marked “B” (bulb), the shutter remains open as long as the shutter release button is depressed, but closes as soon as it is released.

The interval that you want the shutter to remain open is selected by moving a lever or shutter speed dial to that particular setting on the shutter speed scale. Unlike f/stops, the shutter speed you select must align exactly with the index mark You cannot select a shutter speed in between two indicated shutter speeds. On the shutter

speed dial, the top part of the fraction (numerator) is not indicated; for example, the shutter speeds 1/60, 1/125, 1/250, and so forth, are indicated as 60, 125, and 250.

When a camera with a focal-plane shutter is used with an electronic flash, a predetermined shutter speed must be set. At this speed the shutter and flash unit are said to be in synchronization. When the flash and shutter are synchronized, the shutter opening is wide open at the same instant the flash fires. Usually, the slowest shutter speed that syncs with a flash unit is indicated in red or another off color or a lightning bolt symbol on the shutter speed dial.

Function

The shutter serves two functions: controlling the duration of the exposure and controlling subject movement. These two functions are entirely separate and distinct. You must determine the shutter speed required for each condition. After determining the shutter speed, you select the f/stop that provides the correct exposure for the film speed and lighting conditions. Normally, the duration of exposure is short enough to prevent image blurring. You can always set the shutter speed faster than the speed required to stop image motion, but it should not be longer if you want the image to be sharp; for example, when a shutter speed of 1/125 is sufficient to stop subject motion, you can set the shutter speed to 1/250 or faster, but not at 1/60 if you want to stop the motion and produce a sharp image. Each time you change the shutter speed, the diaphragm is adjusted to produce a properly exposed image.

The correct sequence in determining the diaphragm and shutter to produce a properly exposed negative is as follows:

1. Compose and focus the image.
2. Stop down or open up the diaphragm until the desired depth of field is achieved.
3. Select the shutter speed that will produce a proper exposure when combined with your aperture setting.
4. Determine whether the shutter speed is fast enough to prevent image blurring.
5. If the selected shutter speed is too slow, reset it to a faster speed and open up the aperture accordingly.

When you increase the shutter speed, you compromise and loose depth of field. Sometimes this is the only way to produce a useable image. If you cannot sacrifice some depth of field, there are several alternative you can use: select a faster film, increase the camera-to-subject distance, select a shorter focal length lens, or change the camera angle, so the relative motion of the subject to the camera is decreased.

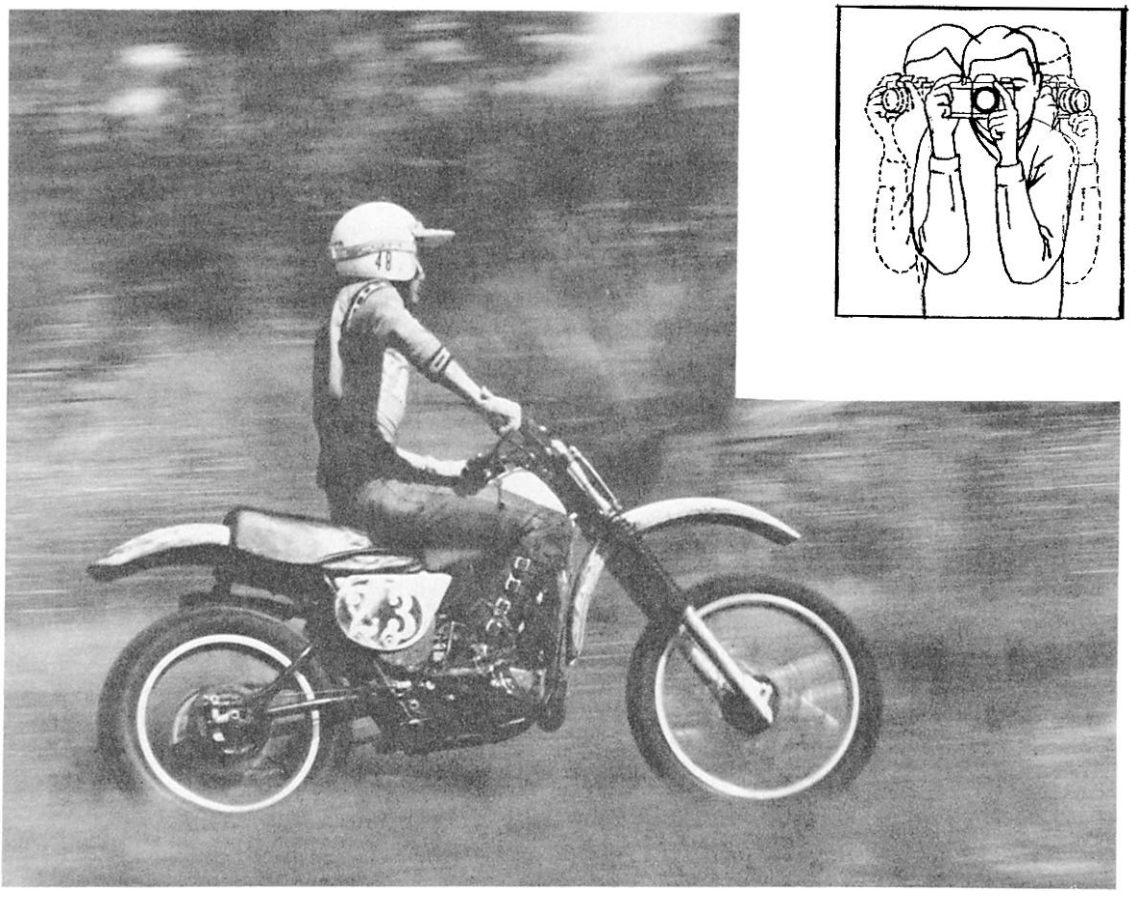
Selecting the Shutter Speed

Knowing what shutter speed produces the right effect for each picture is a skill you, as a Navy Photographer's Mate, must acquire. Your pictures may easily be spoiled by movement of either the camera or the subject. In some instances, this movement can actually improve your photographs.

Novice photographers often find it hard to believe anything can happen during the brief instant the camera shutter is open. This is not true; images can be blurred when a shutter speed as fast as 1/250 of a second is used; for example, when the camera or subject moves during the fraction of a second the shutter is open, the image may be recorded on the film as a blur. Blurring caused by camera movement is noticeable in all images within the photograph. When blurring is caused by subject movement only, the background or some other part of the scene will be sharp, and the subject blurred. Camera movement blur can be corrected by supporting the camera properly or by using a faster shutter speed. Subject image movement can be reduced by using either a faster shutter speed or by panning the subject.

As explained previously, when a faster shutter speed is used, a wider aperture is required to produce correct exposure. For this reason you should know what minimum shutter speed is required to stop or freeze different actions. You must take into account conditions that exist when taking photographs. Strong winds, vibrations, or a ship rolling from side to side must be considered. There is a general rule you must follow for determining shutter speed when handholding a camera. The slowest shutter speed recommended to prevent camera movement blur is to set the shutter speed so it matches the focal length of the lens. When a shutter speed does not exist for the focal length of the lens, select the next highest shutter speed; for example, 1/30 second for a 25mm lens, 1/50 second for a 50mm lens, 1/125 second for a 100mm lens, 1/250 second for a 200mm lens, and so forth.

When a subject is in motion during exposure, the image on the film also moves. Even though the duration of exposure may only be 1/1000 of a second, the image moves a small fraction of an inch during this time. The problem you encounter is how much image movement



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Figure 4-17.–Panning with a moving object.

can be tolerated before it becomes objectionable and adjust your shutter speed accordingly. To determine what forms an objectionable blurring of the image, you must visualize how the photograph is going to be used. An image of a contact print can be much blurrier than an image that is magnified many times. A print that is viewed up close must be much sharper than a print viewed from a distance.

Once you know how the photograph is to be used, you can determine the shutter speed required to produce an acceptably sharp image. In some situations, it may not be possible to produce an image that is completely sharp. When you want a sharp image of a fast-moving object, use the **panning** technique. When using the panning technique, you move the camera and follow the action of the subject until you make the exposure. This method may blur the background but can provide a sharp image of a moving object even at relatively slow shutter speeds (fig. 4-17).

There are five factors that determine the distance an image moves on the film during exposure. You must consider these factors each time you photograph a moving object. These five factors are as follows:

1. The lens-to-subject distance
2. The lens focal length
3. The speed of the object perpendicular to the lens axis
4. The direction of movement
5. The exposure time

Whenever one of these five factors change, the distance the image moves during exposure also changes. The first four factors determine the speed that the image moves across the film. The fifth factor limits the time it is allowed to move, thereby limiting the distance of image movement.

Subject movement on the film plane is greatest when the subject is moving across the angle of view of

the lens (perpendicular to the lens axis). For example, when the subject is moving straight towards or straight away from the camera, it may appear as though it is hardly moving and a fast shutter speed is not required to produce a sharp image; however, when that same subject moves at the same speed across the field of view of the camera, the speed of the subject appears much faster. A faster shutter speed is required to stop the action in this case.

The camera-to-subject distance also affects the amount of image movement at the film plane; for example, a car moving across your field of view at 55 mph from a distance of 700 yards appears to be moving slowly. The same car moving at 55 mph and only 15 feet away appears to be moving very fast; therefore, the closer a moving object is to the camera, the faster the shutter speed must be to capture a sharp image. When the subject is moving diagonally across your angle of view, movement is more apparent than when moving straight away or toward the camera, but less apparent than when moving straight across the field of view.

Remember, long-focal-length lenses exaggerate the effects of camera and subject movement, and short-focal-length lenses reduce the effect.

Experience and common sense are your best guides for determining shutter speed that will minimize image movement, but the following can be used as a guide to help make these determinations:

- Double the shutter speed when the subject speed is doubled.
- Halve the speed when the speed of the subject is halved.
- Double the shutter speed when the camera-to-subject distance is halved.
- Halve the shutter speed when the camera-to-subject distance is doubled.
- Double the shutter speed when the focal length is doubled.
- Halve the shutter speed when the focal length is halved.
- When in doubt, use the next higher shutter speed.

There are mathematical formulas used to determine appropriate shutter speeds for subjects moving at all speeds when photographed with various lenses, but the use of these formulas is not practical. Table 4-2 shows stop motion relationships when a 50mm lens is used. This table is not intended to be memorized but is only intended to provide a better understanding of the relationship of subject motion, distance, and direction.

COMBINING APERTURE AND SHUTTER SPEED

So far three camera controls have been discussed separately: focus, aperture, and shutter. Focus is the most straightforward because it is used to produce a sharp image of the subject. Aperture and shutter each affect the image in two distinct ways. They both control the amount of light that makes the exposure, and they both affect image sharpness. The aperture alters depth of field, and the shutter controls the image movement or blur.

The light-sensitive material must receive the correct amount of light to produce a quality photograph. Under most lighting conditions, it does not matter whether you use a wide aperture with a fast shutter speed or a small aperture with a slow shutter speed. When the combination is correct, both provide the same amount of exposure.

Aperture and shutter speeds each have a doubling and halving effect on exposure. This doubling and halving relationship of aperture and shutter allows you to combine different f/stops and shutter speeds to alter the image, while, at the same time, admitting the same amount of exposure to the light-sensitive material; for example, you have determined that the correct camera settings for your subject is 1/125 second, at f/16. Instead of using this combination of shutter speed and f/stop, you could double the shutter speed (to stop action) and halve the f/stop. In this example your new camera setting could be 1/250 second at f/11, 1/500 second at f/8, or 1/1000 second at f/5.6, and so on. Or when you need more depth of field, 1/60 second at f/22 or 1/30 second at f/32, and so on, can be used. These shutter speed and f/stop combinations are called equivalent exposures. Equivalent exposures are used to control depth of field and to stop motion. Table 4-3 shows some equivalent exposures of a typical situation.

Each of the combinations in table 4-3 produces the same exposure; however, the amount of depth of field and image blur are different in each image. The combination of shutter speed and f/stop is used to best capture the subject and effect you want to create.

You should use a light meter for most of the photographs you take. The light meter provides you with a number of f/stop and shutter speed combinations; however; depending on the situation, the level of light alone can determine the camera settings. For example,

Table 4-2.–Action Stopping Shutter Speeds for Normal-Focal-Length Lenses

Speed MPH	Type of Action	Distance	Direction of Action		
			Across Field of View	Diagonally	Straight Toward or Away
5	Slow walk, working with the hands	12	1/500	1/250	1/125
		25	1/250	1/125	1/60
		50	1/125	1/60	1/30
		100	1/60	1/30	1/15
10	Fast walk/ work, slow-moving vehicles	12	1/1000	1/500	1/250
		25	1/500	1/250	1/125
		50	1/250	1/125	1/60
		100	1/125	1/60	1/30
25	Running, sports, very active people, vehicles moving at a moderate speed	12	1/2000	1/1000	1/500
		25	1/1000	1/500	1/250
		50	1/500	1/250	1/125
		100	1/250	1/125	1/60
100	Very fast-moving vehicles and aircraft	25	1/2000	1/2000	1/1000
		50	1/1000	1/1000	1/500
		100	1/500	1/500	1/250
		200		1/250	1/125

Table 4-3.–Equivalent Exposures

Shutter Speed	f/stop
1/2000	f/4
1/1000	f/5.6
1/500	f/8
1/250	f/11
1/125	f/16
1/60	f/22
1/30	f/32
1/15	f/64

the light level may be so low that you have to use a slow shutter speed and the largest f/stop to get the proper exposure. After determining the correct exposure, you can decide how to present the subject. Remember, depth of field can be used to emphasize your subject, and shutter speed affects subject blur.

EXPOSURE CONTROL

The *term exposure* in photography means the amount of light that reaches the film or other light-sensitive material. The mathematical formula for exposure is the product of light intensity and the amount of time that the light acts on a light-sensitive material. There are two ways a formula is presented in photographic publications. They are as follows:

$$E = I \times T$$

and

$$H = E \times T$$

Where:

E or H = Exposure (lux-seconds or meter-candle seconds)

I or E = Intensity or illuminance (lux or meter candles)

T = Time (seconds)

Both of these formulas represent exposure. The second formula is presented in the more current publications.

As explained previously, camera exposures are controlled by the shutter speed and aperture. The shutter speed controls the time light is permitted to reach the film. The illuminance (or intensity as it is sometimes called) is controlled by the aperture of the camera. The term *illuminance* means the amount of light reaching the film plane. By adjusting these controls, you allow the correct amount of light to reach the film. The correct amount of light varies, depending on the film speed. Correct exposure for negative films is defined as the exposure required to produce a negative that yields excellent prints with the least amount of difficulty. Correct exposure for color reversal film produces color images in densities that represent the appearance of the original scene.

FACTORS THAT AFFECT EXPOSURE

You must consider four major factors that affect exposure when you are taking photographs. These factors are as follows:

- Film speed (ISO)
- Reflected properties of the subject
- Lighting conditions
- Bellows extension

Film Speed

As explained in chapter 2, ISO is a system of rating film speed or sensitivity to light. ISO numbers are arithmetic; that is, an ISO number that is twice as high as another ISO number is twice as sensitive to light. Each time an ISO film speed is doubled, the exposure should be halved. When the ISO is halved, the exposure should be doubled; for example, if the correct camera setting is 1/250 second at f/16 with ISO 100 film, the same subject photographed with ISO 200 film would require only half the exposure or 1/500 second at W16 or 1/250 second at f/22, and so on.

Daylight Conditions

The two primary considerations for determining your exposure under daylight conditions are the intensity and the direction of daylight.

INTENSITY.–From early morning until later evening, even on a clear day, the intensity of daylight is constantly changing as the sun rises, moves across the sky, and sets. Although the intensity of daylight varies throughout the day, the time between about 2 hours after sunrise until about 2 hours before sunset is considered a time when the light intensity for the same geographical location remains constant for exposure purposes.

Daylight conditions for camera exposures can be divided into the following five intensity conditions.

Bright Sun on Light Sand or Snow.–Bright sun is daylight that is not affected by any apparent atmospheric interference. Because of the amount of reflected light from sand or snow, the intensity of light in these scenes is greater than that of a scene with average reflectance. This greater intensity of light requires a higher f/stop or a faster shutter speed to provide approximately one half of the exposure required for the basic exposure with bright or hazy sun.

Bright Sun.–This type of daylight illumination is produced on a bright, sunny day where distinct shadows are present. Bright sun is the condition that determines the BASIC EXPOSURE for an average scene.

Cloudy Bright.–A weak, hazy sun is the result of a heavier or thicker haze or cloud cover as compared to the bright sun condition. The condition causes a decrease in the daylight intensity and an increase in the diffusion of daylight. This lighting condition produces shadows that are soft or indistinct. A lower f/stop or slower shutter speed is required to approximately double the basic exposure to compensate for this decreased daylight intensity.

Cloudy.–Cloudy conditions are the result of a layer of clouds that further reduce the intensity of daylight and diffuse the light completely. This condition occurs on an overcast day when the position of the sun can be located only as a bright area in the clouds. Shadows are not present under this lighting condition. The scene brightness range is low and therefore photographs made during this condition usually lack good contrast. An increase of four times (two f/stops) from the basic exposure is required to compensate for the decreased intensity of light.

Heavy Overcast or Open Shade.–This condition exists when the position of the sun cannot be located. The scene brightness range is low and therefore photographs made during heavy overcast conditions usually lack good contrast. An increase of eight times (three f/stops) to the exposure is required horn the basic exposure to compensate for the decreased intensity of light.

DIRECTION.–The direction of the sun or light source illuminating your subject also affects your basic exposure. The camera settings recommended for films

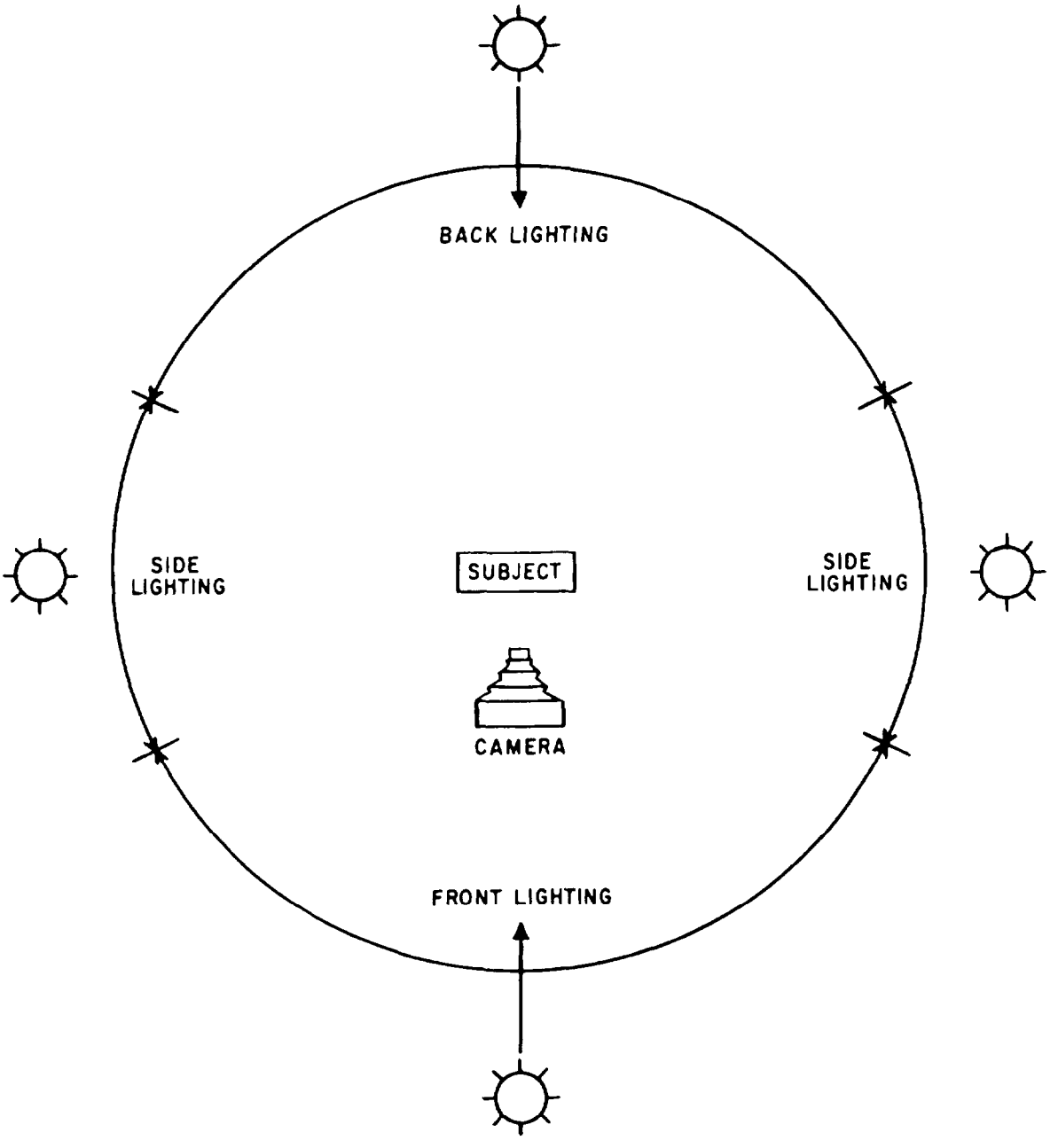


Figure 4-18.–Lighting directions.

exposed during bright sun on light sand or snow, bright sun, cloudy bright, and cloudy conditions are for scenes that are front-lighted only. The direction of the light source from heavy overcast or open shade conditions does not affect exposure because it is extremely diffused and the direction is not apparent.

The amount of light reflected from the scene changes, as the direction of the light changes. As the lighting direction is changed from in front of the subject to behind the subject, the amount of light reflected from the subject is reduced; therefore, depending on the direction from which the light is falling on your subject, you may have to compensate the camera exposure. There are three basic lighting directions with which you must become familiar. These lighting directions are as follows: frontlighting, side lighting, and backlighting (fig. 4-18).

Frontlighting.–Whenever light originates from behind the camera and illuminates the front of the subject, it is called frontlighting. A subject appears brightest and reflects the most light toward the camera when the subject is front-lighted.

Side Lighting.–As the camera is moved in an arc away from frontlighting, less light is reflected from the subject into the lens. Whenever the light source has a 90-degree relationship with the camera, the incident light on the subject is called side lighting. In side lighting situations, part of the subject is in shadow. Photographs of side-lighted scenes usually require two times (one f/stop) more exposure than frontlighted subjects when you want detail in the shadows.

Backlighting.–When the light source is directly behind the subject and aimed toward the camera, it is called backlighting. In back-lighted situations, the subject is in shadow and the light reflected from the subject toward the camera is decreased greatly. A silhouette effect (no shadow detail) of a back-lighted scene is produced by closing down one f/stop from the basic exposure. If shadow detail is desired, an increase of four times (two f/stops) from the basic exposure is required.

Reflection Properties

Otherwise the intensity and direction of light falling on the subject, the texture of the surface, and the colors and shades of the scene also have an effect on film exposure.

SURFACE TEXTURE.–Smooth, glossy surfaces scatter or diffuse reflected light very little; therefore, these objects reflect a large percentage of light to the lens. Rough surfaces greatly scatter and diffuse light. Less light from rough surfaces is reflected to the lens.

COLORS AND SHADES.–Not all light that falls on the surface of a subject is reflected. A brilliant white object reflects a high percentage of incident light, and a black object reflects very little of the light. Between these two extremes are the numerous tones of gray and colors of various hues and brightnesses. Each colored or gray object in a scene reflects a specific amount of light. A scene that consists primarily of light-colored or light-toned objects usually requires an exposure compensation to decrease the exposure as compared to the basic exposure for an average scene. A scene that consists primarily of dark-colored or dark-toned objects usually requires an exposure compensation to provide more exposure as compared to the basic exposure for an average scene. The primary reason light scenes and dark scenes require less exposure and more exposure, respectively, as compared to the average scene, is to maintain detail in the highlight of the light scenes and detail in the shadow areas of the dark scenes.

The color quality of a light source also has an effect on the amount of light reflected from an object; for example, a blue object does not reflect as much light when illuminated with a red light source, as compared to the same object being illuminated with a blue light source. This difference in reflectance is caused by the blue object absorbing the reddish light and reflecting the bluish light.

Any man-made light is an artificial light source. This light may be a tungsten lamp, a fluorescent lamp, a mercury-vapor lamp, and so on. The same factors that affect exposures for daylight apply to artificial light as well. Artificial light has some advantages. Distance, direction, and color temperature can be controlled using these light sources.

Bellows Extension

When copy cameras or view cameras are used, many subjects are photographed at very close distances. When you are photographing at these close distances, it is not uncommon for the bellows of these cameras to extend beyond one focal length. The farther the bellows are extended, the larger the image size produced at the film plane. When a 1:1 subject to image ratio (on the film plane) is needed, the bellows are extended to two times the focal length of the lens; for example, when a 6-inch lens is used to produce a 1:1 ratio, the bellows are extended to 12 inches. The distance the bellows are extended is determined by measuring the distance from the optical center of the lens to the film plane.

When the bellows are extended beyond one focal length, an exposure compensation is needed. Because light must travel a greater distance, some of the intensity is lost. This loss of light intensity must be compensated for by opening up the aperture or increasing the exposure time. There are two formulas used to adjust the exposure when the bellows are extended.

Generally, the exposure time is extended to compensate for bellows extension, because view cameras and copy cameras are mounted securely and the critical aperture is used to produce the sharpest image. To adjust the exposure time, use the following formula:

$$\left(\frac{BE^2}{FL}\right) \times T = NEW\ EXPOSURE\ TIME$$

Where: BE = Bellows extension

FL = Lens focal length

T = Indicated exposure time

EXAMPLE: You are photographing a document with a camera that has a 5-inch lens and the bellows are extended 7 inches. Your light meter indicated an exposure of 1/30 second at f/4. The new exposure time is determined as follows:

$$\left(\frac{7}{5}\right)^2 \times \frac{1}{30} = 1.96 \times \frac{1}{30} = \frac{1.96}{30} = \frac{1}{15} \textit{ SECOND.}$$

To adjust the aperture, use the following formula:

$$\frac{\textit{indicated f/stop} \times \textit{focal length}}{\textit{lens-to-film distance}} = \textit{adjusted f/stop}$$

EXAMPLE: A 4-inch lens is extended to 4 inches beyond one focal length. The original camera settings are 5 seconds at f/11. Using the above formula, the problem is solved as follows:

$$\frac{11 \times 4}{8} = \frac{44}{8} = 5.55 \text{ or } f/5.6.$$

f/16 RULE

You should use a light meter for most of the photographs that you take in the fleet. These light meters are either built into the camera or are separate hand-held models; however, there may be times when your light meter does not operate properly, or you do not have time to use it in order to "grab" an awesome shot. The f/16 rule of exposure allows you to determine basic camera exposure settings for both black-and-white and color photography without the aid of electronic devices.

The f/16 rule states: The basic exposure for an average subject in bright frontal sunlight is

f/16 at: $\frac{1}{\text{film speed}}$

Therefore, to calculate the BASIC exposure for bright, sunny conditions, set f/16 on the camera lens and use the IS0 speed of the film for the shutter speed; for example, when you use IS0 125 film, set the shutter speed at 1/125 second and the lens aperture at f/16. For IS0 64 film, set the shutter speed at 1/60 second and the lens aperture at f/16, and so on. When the camera does not have a shutter speed corresponding to the IS0 of the film, use the shutter speed that is closest to the IS0 of the film.

The f/16 rule is based on the correct exposure for an average subject under bright, sunny conditions. If the sun goes behind a cloud, however, then the lighting on the subject is decreased and you must change the basic exposure. The aperture settings for different daylight intensities are as follows:

- Bright sun on light sand or snow-f/22
- Bright sun-f/16
- Cloudy bright-f/11
- Cloudy-f/8
- Heavy overcast or open shade-f/5.6

For each of these different daylight intensity situations, you begin with the ISO speed to determine the shutter speed, set the aperture to f/16, and open up or stop down the aperture for the lighting conditions.

After calculating the exposure, you can change the setting to any equivalent exposure; for example, if you determine the required exposure to be 1/500 second at f/5.6 but you wish to use a small aperture for greater depth of field, you can change the setting to 1/60 second at f/16.

Remember, the f/16 rule provides you with a basic exposure for front-lighted subjects only. When the subjects are side-lighted or back-lighted, you must double or quadruple the exposure, respectively.

Because many cameras are fully automatic, you may wonder why you need to know basic exposure. There are three good reasons for knowing and understanding the basic principles of exposure. First, you want to control the depth of field and stop action instead of the camera controlling it. Second, a light meter cannot think All a light meter does is respond to the light it receives. You must know when to override the camera; for example, when the subject is side-lighted or back-lighted. Third, meters are mechanical and can fail. They can be inconsistent, consistently wrong, or fail altogether. When you can workout in your head, roughly what the camera exposures should be, you will know when the camera or light meter is wrong. Knowing when a light meter is giving incorrect readings could make the difference between success or failure of an important photographic assignment.

LIGHT METERS

The correct use of a light meter greatly increases the accuracy in determining your camera exposure. You should also understand that the incorrect use of a light meter can result in consistently unacceptable results. To assure consistently acceptable exposures, you must become thoroughly proficient with the correct operation of a light meter.



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Figure 4-19.–Hand-held light meter.

A light meter can be either built into the camera or a separate hand-held unit (fig. 4-19). Both types are sensitive instruments and should be handled with care. There is little maintenance, but they do require batteries. When you think a light meter is not working properly, have it checked by a qualified technician. Always be sure to check your equipment before leaving on an assignment. Like all camera equipment, careless handling and excessive heat and moisture limit the life of a light meter. A light meter must not be subjected to high temperatures for prolonged periods of time. Unless the light meter is designed for underwater photography, it should be protected in inclement weather.

LIGHT METER READINGS

There are two methods of measuring light with hand-held light meters. These two methods are the incident-light method and the reflected-light method.

Incident-Light Method

This method requires the use of an incident-light meter. An incident-light meter has a diffusing dome that covers the photoelectric cell. When an incident-light meter reading is taken, the meter is held at the position of the subject with the photoelectric cell pointed toward the camera. The meter measures the light falling upon the scene. The incident-light method of measuring light is used extensively in motion-media photography and gives fast accurate results in all photography.

Most light meters are designed for use as either incident-light or reflected-light meters. By removing the diffusion dome from the photoelectric cell, you can use the meter to measure reflected light.

Reflected-Light Method

When you are taking this type of light-meter reading, the diffusing dome should be removed from the photoelectric cell and the meter pointed toward the subject.

A reflected-light meter receives and measures the light reflected from a scene within the angle of acceptance of the meter. The term *angle of acceptance* compares to the term *angle of view* of a lens. Both are predetermined during manufacturing. The angle of acceptance and the distance between the meter and the scene are the controlling factors as to how much of the reflected light from the scene is measured by the meter. When the angle of acceptance is greater than the angle of view of a lens (when using a telephoto lens for example), the meter should be moved closer to the scene.

Light meters that are built into the camera are reflected-light meters. When these meters are used, the angle of acceptance is not greater than the angle of view of the lens being used. The meter measures the light from the scene as seen by the lens.

Some reflected-light meters have angles of acceptance between 1 and 4 degrees. These meters can be used from a distance to measure the reflected light from specific objects within a scene. Exposure meters with angles of reflectance this small are called **spot meters.**

LIGHT METER OPERATION

You must understand the way light meters operate to determine whether the information they provide is accurate. No matter what type of light meter you use, it

is an electrical-mechanical device that can only provide information for which it is designed. You are responsible for translating this information into useful exposure data.

Light meters are calibrated to see one shade only-middle gray. This means the information that the meter provides, no matter how much light is falling on the subject or what the reflection characteristics are, reads the subject the same as though it were middle or neutral gray (18-percent gray). Theoretically, if you take a reflected-exposure meter reading from an 18-percent gray card and expose your film according to the reading, the result should be a picture that matches the tone of the gray card exactly; however, when you take a light meter reading of a white or black object, the light meter still reads the objects as though they were 18-percent gray.

When you take a photograph that includes a gray, white, and black card, you will see how, depending on where you take the light meter readings, they affect your photograph; for example, when you take the light meter reading from the black card, the final picture reproduces the black as middle gray, and the gray and white cards as white. When you take the reflected-light meter reading from the white card, just the opposite occurs. In your final picture, the white card reproduces as middle gray, and the gray and black cards reproduce as black.

This example demonstrates overexposure and underexposure. When the reading was taken from the black card, the meter raised the black tone to middle gray, and the gray card tone was also raised so it reproduced as white. Thus both the black and gray cards were overexposed The opposite occurred when the exposure was based on the reading from the white card. The white tone was lowered to middle gray and the gray card tone to black, resulting from underexposure. Only a light meter reading taken from the gray card allows all three cards to be imaged at their true tone.

A more practical example on the way a light meter reads 18-percent gray is illustrated in the following example. Suppose you are going to photograph a ship alongside a pier. Bright sunlight is striking the ship from the side, causing part of the ship to be in shadow. This creates a brightness difference between the highlight area and the shadow area. Both highlight and shadow areas are equal in size and importance. When you get close to the ship and take a reflected meter reading of the highlight area alone, you expect the finished photograph, like the white card in the above example, to be middle gray. When you stop down the aperture to the recommended exposure of the meter, you are also reducing the amount of exposure from the shadow area. This results in a loss of detail in the shadow area of the ship, because it is underexposed. The opposite effect occurs when you take a meter reading from the shadow area. In this case, the shadow tones are raised to middle gray and have detail, but the highlights are overexposed and completely "washed out."

If, however, there was an area in this scene whose tone was midway between the highlight and shadow areas, you could use it to take your light meter reading (like the gray card was used in the previous example). In this example, assume there is no tone midway between the two extremes. You can still get an accurate light meter reading of the entire ship. Since the highlight and shadow areas are of equal size, the *average* light meter reading you get will represent a tone that is midway between the two extremes.

REFLECTED LIGHT METER READING VARIATIONS

There are variations of light meter readings used to provide accurate light meter readings of different types of scenes. These methods are as follows: the integrated, or average, method, the brightness range method, the darkest object method, the brightest object method, the substitution method, and the bracketing method.

Integrated, or Average, Method

The technique of making reflected-light meter readings from the camera position is called the *integrated,* or *average,* method. This method was used and explained in the examples above. This method is accurate for the majority of photographs taken.

The integrated, or average, method of measuring reflected light is acceptable for scenes that consist of approximately equal portions of light and dark areas; however, when a scene is composed of either predominately light or dark areas, the meter reading may not be accurate.

The reason for these inaccurate meter readings can be more easily understood by using an example of photographing a checkerboard with alternating black-and-white squares. When the meter is held at a distance to include the entire board, the reflected light from both the black and the white squares influence the meter, so an average reading results. The light measured from this position is the integrated sum of both the white and the black squares, as though the checkerboard were one gray tone. The light meter reading from this point should produce an acceptable image.

If you hold the meter so close to one of the white squares that the black squares have no effect on the meter reading, the reading is higher than the integrated reading and the meter indicates that the scene requires less exposure. The same principle applies when a reading is taken close to a black square. The reading indicates that the scene requires more exposure. Each of the meter readings is a measurement of 18-percent gray. You can apply this checkerboard example when you photograph scenes that are predominately light or dark Compensation is required to expose such scenes correctly.

As a general guide, you should double the indicated exposure when the light measurement is taken from a predominately light scene and detail is desired in the shadows. When you take a light meter reading from a predominately dark scene and detail is desired in the highlight areas, you should reduce the exposure by one half.

Brightness Range Method

This method requires you to take two readings from the scene: one from the highlight area where detail is desired and another from the shadow area where detail is desired. You then base your exposure on a point midway between the two readings.

The brightness range method of determining exposures for most scenes usually provides detail in both the highlight and the shadow areas. An exception to this is when the exposure latitude of a film is not capable of recording the brightness range of the scene. This can occur with scenes that have extremely great brightness ranges. A scene brightness range is the difference between the brightest and the darkest areas of a scene and is usually expressed as a ratio. The average brightness range of a normal scene is 160:1. Films used for pictorial work are capable of reproducing this brightness range. When the scene exceeds a brightness range of 160:1, you must compromise the exposure. This compromise can be as follows:

- Underexpose and sacrifice shadow detail to retain highlight detail.
- Overexpose and sacrifice highlight detail to retain shadow detail.
- Do not compensate and expose for the midtones and sacrifice both highlight detail and shadow detail.

Darkest Object Method

The darkest object method of determining exposures is actually a variation of the brightness range method. When you desire detail in the shadow area or darkest object within the scene, you take the light meter reading from this area. This method actually overexposes the film overall, causing the highlight areas of the scene to be greatly overexposed. This overexposure occurs because the light meter averages the light reflected from the shadow area and indicates an exposure to produce middle gray. When a great amount of detail is not needed in the shadow area and you want to expose the overall scene normally, you can take your light meter reading from the darkest object or shadow area and stop down two f/stops. This method provides a good overall film exposure of the shadows, midtones, and highlights.

Brightest Object Method

Another variation of the brightness range method is the brightest object method. The brightest object method of calculating exposures is used when a highlight area within a scene is the only area within the scene from which you can take a light meter reading. This method can also be used when you want to record detail in the highlight area In both situations, you take only one light meter reading of an important highlight area. When you do not want the highlight to record as a middle-gray tone and desire a good overall exposure of the scene, you simply open up two or three f/stops from the indicated exposure. When you need maximum detail in the highlight area, you can use the reading that the light meter provides. This records the highlight area as medium gray. This method underexposes the film in other areas of the scene that reflect less light.

Substitution Method

With the substitution method, you replace an object within the scene with an object, such as a gray card. You then take a reflected-light meter reading from this object. You use this method when the other methods of determining exposure are not possible. Such situations may be caused by excessive distance between the light meter and the scene, barriers in front of the scene, or the size of the scene makes it impossible to get an accurate light meter reading. The substitution method is often used in studio situations where objects may be too small to obtain an accurate light meter reading.

You should select substitution objects that match the light reflectance quality of the object in the scene; for

example, a white card can be used to substitute highlight areas of a distant scene. A dark or a black card can be used to substitute a shadow area, an 18-percent gray card can be used to represent middle gray, or the back or palm of your hand can be used to substitute a gray tone.

When the substitution method is used, take the light meter reading from the substituted item under similar lighting conditions that exist in the scene. When the scene is in bright sunlight, the substituted object must also be in bright sunlight. Likewise, a scene in shade requires a substitute light meter reading in shade.

You can use each of the methods discussed previously with the substitution method. An 18-percent gray card can be used for the integrated or averaging methods, a dark and a light card can be used for the scene brightness range method, a dark card for the darkest object method, and a light card for the brightest object method.

Bracketing Method

There are times when unusual lighting or subject brightness prevents you from getting an accurate light meter reading. In these cases, a good insurance policy is to bracket your exposure. To bracket, you should take one picture at the exposure indicated by the light meter, and then take two more exposures: one at one f/stop under the indicated exposure and another at one f/stop over the indicated exposure.

When you are in doubt about the correct exposure for a negative type of film, it is always better to overexpose than underexpose. Even though overexposure produces excess densities in the negative, it still provides a useable image that can normally be corrected in the printing stage. When underexposed, if the image does not exist on the film, no corrective printing techniques can provide image detail.

When shooting reversal film (slides), you should bracket in 1/2 f/stop intervals. Because the exposure latitude of slide film is limited to ± 1/2 f/stop, you should bracket in 1/2 f/stop increments, both under and over the indicated light meter exposure reading. Color slides that are 1/2 f/stop underexposed have more color saturation and are more usable than ones that are 1/2 f/stop overexposed and appear “washed out” and light.

TAKING LIGHT METER READINGS

When taking light meter readings, you must be sure the reflected light that influences your light meter is actually from the object you want to photograph. Stray light, backlighting, large dark areas, and shadows can all cause erroneous light meter readings. When using a light meter, be sure that shadows are not cast from the light meter, camera, or yourself. When a hand-held light meter is used, the distance of the light meter to the subject should not exceed the shortest dimension of the object; for example, when taking a light meter reading of a person’s face that is approximately 9x6 inches, you should hold your light meter about 6 inches from the face of your subject when taking the meter reading. When using a light meter that is built into a camera, be sure to focus on the image before taking a light meter reading.

CAUSES OF FALSE LIGHT METER READINGS

There are a number of reasons why light meters give erroneous or bad readings that produce underexposed images. You can prevent these bad readings by being aware of the conditions that cause them.

Light Entering the Viewfinder

Light entering the viewfinder and falling on the viewing screen can cause underexposure. Most TTL meters read the light falling on the viewing screen from the lens. When strong lighting is coming from behind the camera, it can influence the light meter. When an occasional underexposed frame in an otherwise successful series occurs, the cause may be light entering the SLR viewfinder. Make a point of shielding the viewfinder if you do not have a rubber eyecup. When you use a tripod, have the camera set on automatic and cap the viewfinder to prevent exposure errors.

Incorrect Film Speed Setting

When the majority of frames on a length of film are consistently underexposed or overexposed, the most likely cause is you have the wrong ISO set on the film speed dial. For black-and-white film and color reversal film, it may be possible to compensate for this in developing if detected before the film is processed.

Bright Subject

A bright object or highlight area can affect the sensing area of a spot or center-weighted TTL meter. This results in an underexposed image. To prevent this from occurring, you should ensure the sensor is pointed directly at a midtone within the scene, and use this as the camera exposure. When you frame and compose



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Figure 4-20.–4x5 Graphic View II camera.

your image, the light meter may indicate a different setting. Be sure to leave your camera set at the indicated midtone setting. Normally, light meters that take integrated or averaged readings of the field of view cannot be fooled in this instance. But remember, even integrated systems cannot cope with extremely bright areas that take up a significant portion of the frame.

Bright Background, Dark Subject

When you are taking photographs that are back-lighted or against a light background, there is always the danger of underexposing the main subject (unless you use special techniques to fill in shadows, such as using a reflector or a flash unit). Be careful to take a reading from only the shadow side of the subject in these situations.

Too Little Light

The most frequent cause of underexposure is trying to take pictures when there is not enough light. Light meter readings are not very accurate at these low-light levels. When you want to make photographs under these conditions, be sure to use a tripod and bracket to provide more exposure than indicated by the light meter. You also can switch to a higher IS0 film. Some of the high-speed films marketed today can provide remarkable results.

There are several other causes that may cause your images to be exposed incorrectly. Some of the most common causes are listed as follows:

- Wrong camera settings are set when transferring information from a hand-held light meter to the

camera. This can also occur when you attempt to override an automatic camera.

- Using a camera with TTL metering and placing a color filter with a high-filter factor over the lens.
- Wrong aperture setting when flash is used.
- Shutter speed is not synchronized with camera flash.
- Aperture or shutter speed setting is knocked while carrying the camera. Always check the camera setting before taking a photograph.
- Weak or incorrect battery in the light meter.

VIEW CAMERA

The view camera (fig. 4-20) is a flexible and useful camera that, due to laziness, is frequently overlooked by Navy imaging personnel. Through the use of rising or falling fronts, swings, tilts, and shifts, you have complete control over the composition of the subject. View cameras are excellent for photographing construction, large groups of people, landscapes, small parts, damaged material, buildings, and many other subjects, because distortion can be controlled or corrected The camera has bellows that may be extended to make it suitable for copy work and photographing small objects. Most view cameras used in the Navy use 4x5 sheet film. View cameras are not suitable for sports or uncontrolled action situations where a hand-held camera is needed.

View cameras do not have viewfinders or range finders. Viewing and focusing is done on ground glass. The ground glass is located exactly the same distance from the lens as the film; therefore, the image viewed on the ground glass is the same that is recorded on the film. View cameras have interchangeable lenses and between-the-lens leaf shutters.

BASIC CONTROLS AND FUNCTIONS

All view cameras are basically the same. Generally, all view cameras have the following standard parts:

- Monorail or bed. Serves as the base or support to hold all the other components.
- Front lens standard. Permits the lens to be locked into any position on the monorail. The front lens standard also permits the lens to swing, slide, tilt, rise, and fall.
- Rear standard. The rear standard holds the film holder and has swing, tilt, and slide controls.

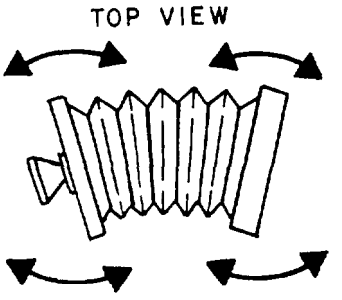
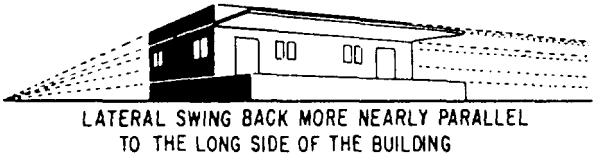


Figure 4-21–Swing movement of front and rear standards.





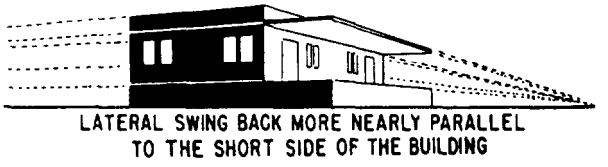


Figure 4-22.–Correction for horizontal distortion.

- Bellows. Connects the front and rear standards and allows the two standards to move for focusing or to accommodate various focal-length lenses.
- Tripod head. Holds the monorail to the tripod.
- Lens.
- Ground glass. Used for focusing, viewing, and composing the image.

There are four basic movements or adjustments used on a view camera. These basic movements perform specific functions. The four basic movements are as follows:

1. **Horizontal or lateral swing.** Both the front and rear standards swing horizontally (fig. 4-21).

The swing back is used to correct distortion, or perspective, in the horizontal plane. When you are photographing subjects from an angle, horizontal lines appear to converge at the distant side. To correct this distortion, swing the camera back so it is more parallel to the horizontal plane of the subject (fig. 4-22).

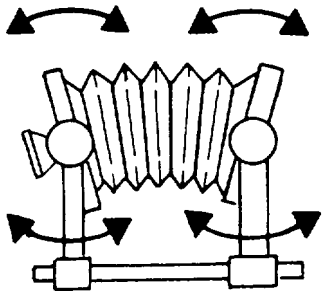


Figure 4-23.–Front and rear vertical tilt movement.

The front standard swing allows the lens to pivot horizontally around its optical axis. The swing front is used to increase the depth of field. When the swing back is swung, the film is not parallel with the image produced by the lens. By swinging the lens, you can bring the image onto the same plane as the film.

2. Vertical tilt. Both the front and rear standards tilt vertically (fig. 4-23).

The tilt back is used to correct distortion, or perspective, in the vertical plane. When you angle the camera up to photograph a subject, such as a building, the vertical lines on the ground glass appear to converge. When this distortion is not corrected, the subject appears smaller at the top and the vertical planes bend toward the center of the image (fig. 4-24, view A). To correct this distortion, tilt the tilt back so it is parallel to the vertical plane of the subject (fig. 4-24, view B).

The tilt front is used to focus and increase the depth of field. When the tilt back is tilted to correct for vertical distortion, the film plane is no longer parallel to the image produced by the lens. By tilting the front standard, you can bring the image of the lens onto the same plane as the film.



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Figure 4-24.–Uncorrected and corrected vertical distortion.

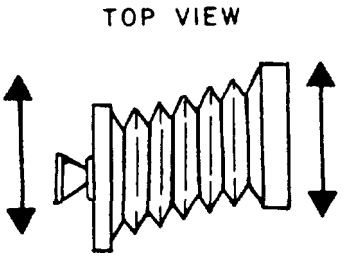


Figure 4-25.–Sliding front and rear of view camera.

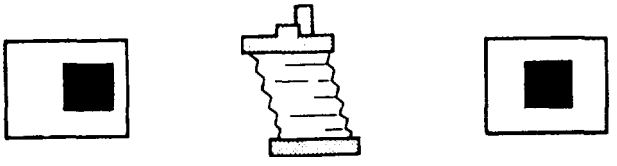


Figure 4-26.–Using sliding controls to center image.

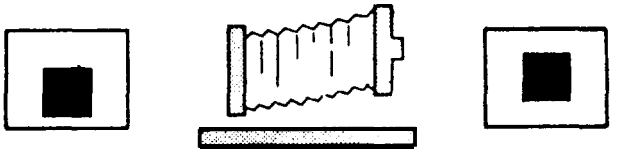


Figure 4-27.–Using rising and falling front-to-center image vertically.

3. Slide or shift. Both the front and rear standard shift or slide from side to side (fig. 4-25).

The sliding front or sliding rear is used to center the image on the ground glass horizontally (fig. 4-26). The sliding front or sliding rear is used when the image is not centered after the camera is set on a tripod. These controls are used instead of moving the tripod. When the tripod is moved, the horizontal corrections are altered and must be reevaluated.

4. Rising and falling front. The rising and falling front is used to center the image vertically on the ground glass (fig. 4-27). This control raises and lowers the lens board. This prevents you from tilting the entire camera and nullifying the distortion corrections made on the vertical plane.

VIEW CAMERA OPERATION

The view camera is easy to use, but this requires some thought and patience to use it properly. The more the camera is used, the more comfortable you will be with it. The following progressive steps are used when using the view camera:

1. Set up and level your tripod.

2. Set the camera controls to the neutral position. The neutral position is the starting point for photographs taken with a view camera. In the neutral position, all controls are lined up and no corrective movements are set. Adjust the front and the rear standards so they can be moved to focus the image.

3. Open the shutter and set the diaphragm at maximum aperture.

4. Roughly compose the image on the ground glass.

5. Focus the image.

6. Check the image size and subject coverage. When required, change lens focal length, camera-to-subject distance, or both. Small image size adjustments may be made by sliding the monorail forward or backward.

7. Correct distortion by using the swing and tilt controls. The image must be refocused after each control is moved.

8. Recenter the image horizontally by using the sliding front or the sliding rear. The image is recentered vertically by using the rising and falling front.

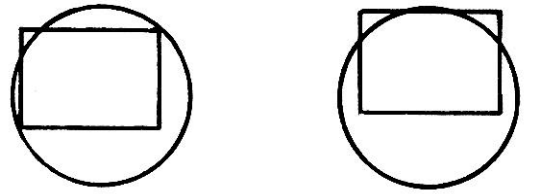
9. Refocus the image. To obtain greater depth of field, swing or tilt the lens board so it is parallel with the film plane.

10. Refocus.

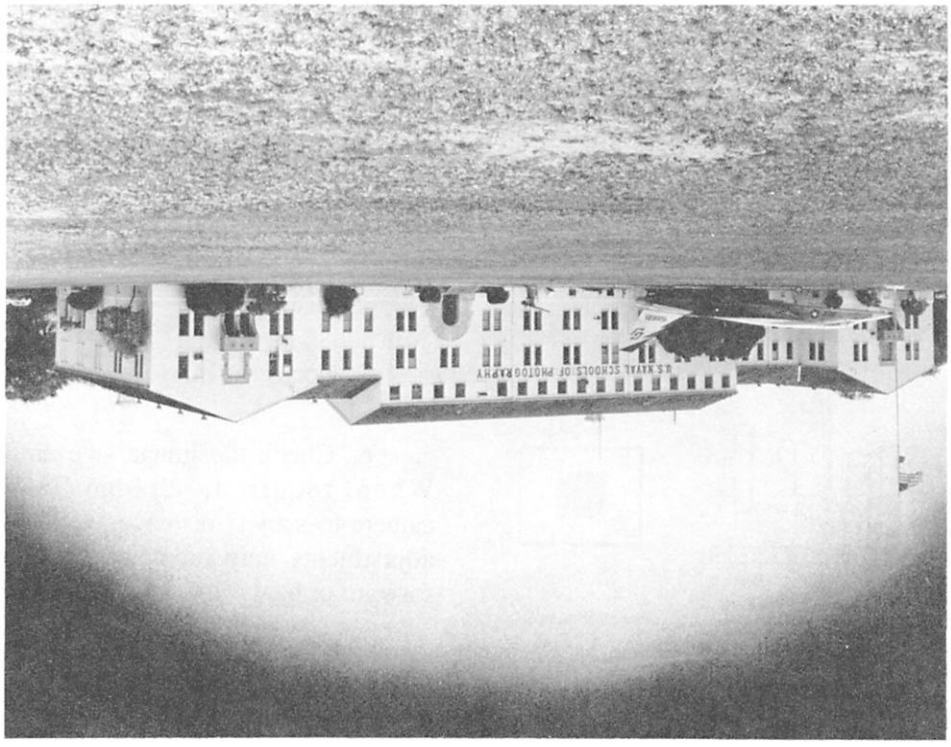
11. Determine your exposure. When necessary, be sure to take the bellows extension into account.

12. Stop down the diaphragm and check the depth of field.

13. Check the circle of illumination. You will loose the circle of illumination when extreme camera



ILLUMINATION OF CAMERA MOVEMENTS.



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Figure 4-28.–How the loss of the circle of illumination appears on the ground glass.

movements are made. This is caused when the lens field of coverage is shifted from the film plane (fig. 4-28).

14. Be sure all camera adjustments are locked down and insert the film holder. Be sure the lens is closed before removing the dark slide.

15. Make your exposure.

You cannot always correct 100 percent of the distortion. Horizontal or vertical distortion can only be corrected on one plane; for example, when you take a three-quarter photograph of a building, only the front or side can be corrected at a time, not both in the same picture.

ELECTRONIC CAMERAS

Still-electronic cameras are becoming popular in all branches of the Department of Defense. The operation of still-electronic cameras is basically the same as conventional cameras. The only difference between these cameras is the way the images are recorded and stored. There are two different types of electronic cameras used currently in the Navy: the still-video camera and the digital camera.

The Sony ProMavica MVC-5000 (Magnetic Video Camera) is an example of a still-video camera. The ProMavica records images as magnetic impulses on a compact 2-inch still-video floppy disk. The images are captured on the disk by using two-CCD (charge-coupled device) chips. One chip stores luminance information, and the other separately records

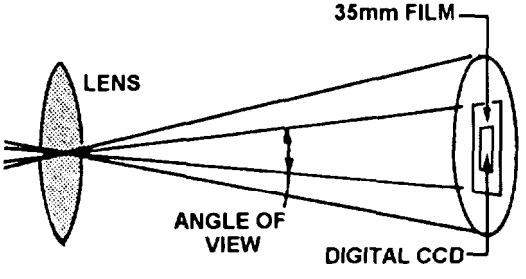


Figure 4-30.–Comparing the angle of view of a 35mm camera and the Kodak DCS Digital camera.

the chrominance information. This camera provides a 720,000 pixel image.

The images can be stored on the floppy disk either as a **FRAME** or a **FIELD.** When *frame* is selected, each picture is recorded on two tracks and up to 25 images can be recorded on each disk. When *field* is selected, each picture is recorded on only one track, allowing up to 50 images to be recorded. When you record your pictures in the field mode, images are less detailed as compared to images recorded on two tracks (frame).

Overtaking the still-video camera is the digital camera. The Eastman Kodak Company is leading the way in digital-imaging technology by introducing the Digital Camera System (DCS). Resolution with the Kodak DCS 200 Digital camera is 1.54 million pixels,



PHAN(AC) April Hatton
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Figure 4-31.–Image captured and transmitted using the Kodak DCS Digital camera.

providing four times the resolution of a still-video camera. Kodak's fully digital systems use a Nikon body and optics to capture the image. The image is then transferred to a highly sensitive CCD that converts the image directly into digital information. The CCD in the Kodak DCS camera system only uses a small portion of the angle of view compared to conventional cameras; for example, a 28mm lens on the Kodak DCS Digital Camera is equivalent to an 80mm lens on a 35mm camera (fig. 4-30).

The exposure index (EI) of the DCS camera equates to 50 to 400 IS0 for color images and 100 to 800 IS0 for black-and-white images. The digital images stored on the DCS camera can easily be downloaded to a computer, so it can be manipulated and printed or can be transmitted around the world without loss in quality. The image in figure 4-31 was transmitted directly from the USS *Ranger* CV-61 via satellite to the Navy News Photo Division in the Pentagon.

CHAPTER 5

BASIC PHOTOGRAPHIC TECHNIQUES

Today, photography is characterized by a rapid growth in the development of technology and ideas. Each year, millions of pictures are taken and an astonishing array of new films, cameras and imaging systems enter the market.

One of the great attractions of the photography field is the ease with which basic skills can be learned. Unlike some of the older arts that take years of training to produce an acceptable product, anyone can quickly learn how to take a picture; however, photographic techniques must be mastered before you can become an accomplished photographer; therefore, mastery of the basic fundamentals is the foundation upon which you will build your photographic and professional skills as a Navy Photographer's Mate. The photographic techniques presented in this chapter are essential in producing quality photographs, and you can apply each of these fundamentals, to some extent, each time you take a picture.

KEEPING THE CAMERA STEADY

Many photographs have been ruined because of camera movement. Unless you want a blurred picture, keeping your camera steady when shooting is crucial. The longer the exposure or focal-length lens you use, the more crucial holding your camera steady becomes; therefore, there are many instances when the use of a tripod or some other type of camera support is necessary.

The following section provides general guidelines for the various methods used to support a camera to ensure quality results. These are not necessarily the only or even the best ways to support a camera. You should practice supporting your camera using various methods; then select those that are most appropriate for the situation and the subject being photographed. Practice should include all the camera functions you normally use on actual photographic assignments. Concentrate on composing through the viewfinder, focusing, selecting shutter speeds and f/stops, holding the flash off the camera, depressing the shutter release, and winding the film.

HANDHOLDING THE CAMERA

Of the various methods to keep your camera steady, the best is to use a tripod, but often you may not have one with you or the situation makes the use of a tripod impossible. In these situations, if you use proper precautions, it is possible to take high-quality pictures using hand-held methods.

Under normal circumstances, you should not handhold your camera at shutter speeds longer than about 1/60 second. When a long lens is used, this becomes even more critical, because the images produced by long lenses are affected more by camera movement. Also, it is more difficult to control the weight and greater size of a long lens when it is hand-held. As a general rule, the slowest recommended shutter speed is the reciprocal of the focal length of the lens; for example, when you are using a 500mm lens, the slowest shutter speed you should use is 1/500 second. When handholding your camera, be sure to have a good, solid, but not tense grip on the camera. Use your whole body as a firm support. Your elbows should be close to your body and your feet spread apart to provide good balance. In this position your body is acting as a tripod. When possible, you should try steadying yourself by leaning against something solid like a wall, tree, or post.

When using an eye-level camera, press the camera against your forehead and face. A waist-level camera should be pulled solidly against your body. Just before releasing the shutter, take a deep breath, let out part of the air-hold the rest, and squeeze the shutter release as if firing a gun.

When nothing is available to support your camera other than yourself, try sitting down, squatting, or kneeling, and firmly rest your elbows on one or both knees. When you are taking low-angle photographs, lying on the ground with the camera in front of you is another simple way to keep the camera reasonably



Figure 5-1.–Handholding the camera.

steady. Even better results are obtained when you place the camera on a solid surface, such as a railing or a rock (fig.5-1).

When taking high-angle photographs with a twin-lens reflex or waist-level camera, you could hold the camera steady upside down against a roof or other object within easy reach above your head, such as under a low archway or firm tree branch.

Portable and compact supports, such as pistol or rifle grips, are available for hand-held cameras. These

are particularly useful when covering fast events, when using long-focal-length lenses, or when a tripod is too cumbersome to use. These hand-held supports are usually fitted with a cable release for firing the shutter.

Camera shake can cause *fuzzy* photographs. Some cameras have built-in capabilities that help reduce camera vibration or shake; for instance, on a single-lens reflex (SLR) camera, the mirror "jumps" up when the shutter is fired-that causes vibration. On some SLRs you can lock the mirror up before taking the picture to avoid this; however, the disadvantage of locking the mirror is that you are unable to see through the viewfinder. Also, the pressure of your finger on the shutter release can cause some camera shake. 'This does not happen on cameras with a delayed shutter release because the camera compensates by automatically delaying the shutter release. Additionally, cable release can be used to fire the shutter without handling the camera

CAMERA SUPPORTS

To ensure absolutely sharp photographs, you must use some type of camera support. Few photographers can hold a camera absolutely steady, especially for exposures longer than about 1/60 second or even shorter exposures when using long-focal-length lenses. When using telephoto lenses or shooting motion media, you must remember that camera movement can become critical. Even the slightest camera movement is magnified and becomes very apparent in enlargements of still photographs or when motion-media footage is viewed.

The ideal camera support should be strong, firm, and allow as much adjustment of camera height and angle as possible. The design of a support to be carried outside the lab should be compact and lightweight, while still providing a firm, rigid camera support.

Most pictures are taken holding the camera by hand because camera supports are often bulky, heavy, and inconvenient to carry on many assignments; however, you should use a camera support when it is appropriate to do so. This allows you to produce the sharp pictures that are characteristic of a truly professional photographer.

Tripods

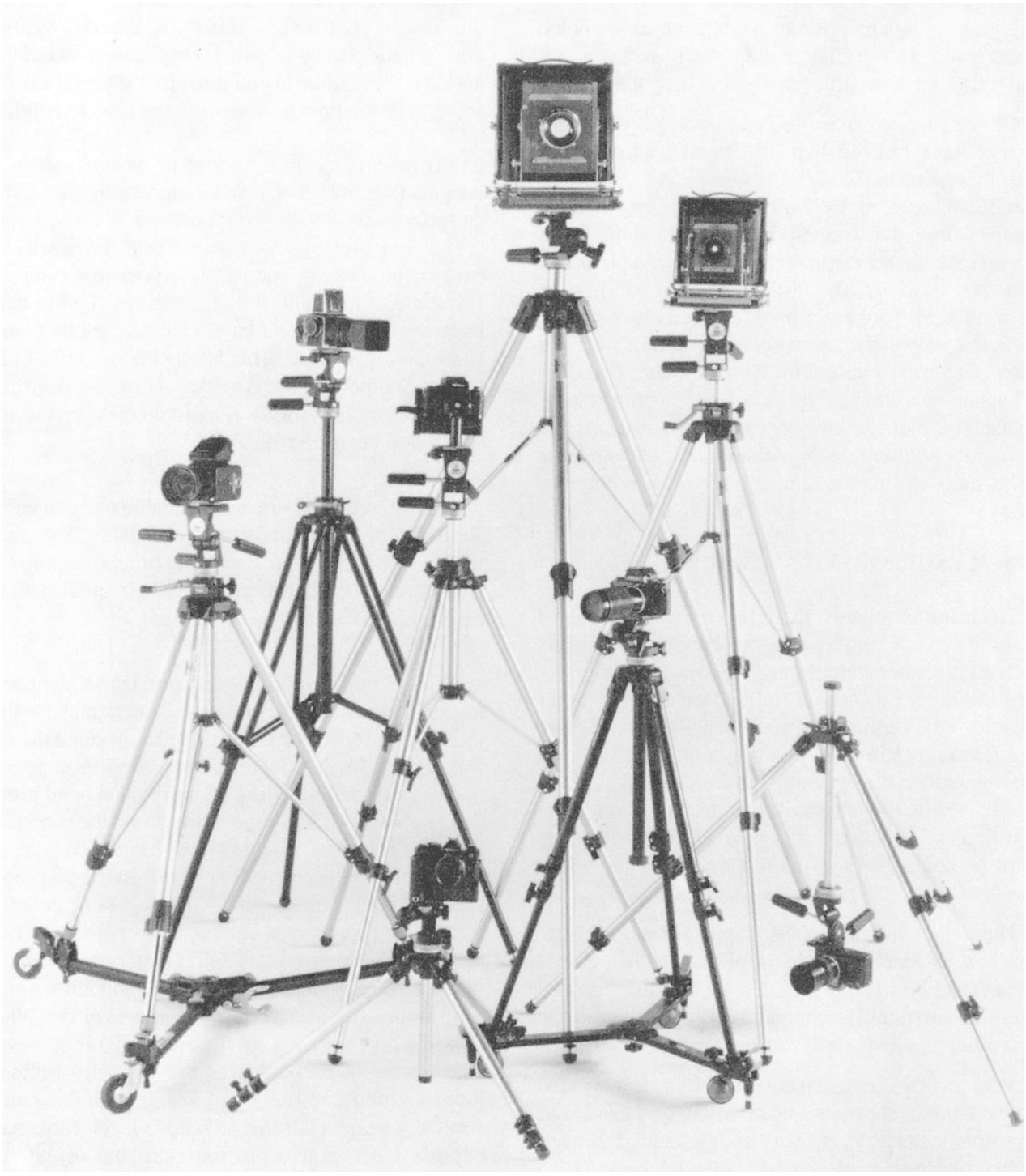
The best way to support your camera is with a sturdy, rigid, tripod. Tripods are three-legged camera supports with flat platforms or heads in which cameras are secured. Most tripods are equipped with a head that has an elevator center post. The camera is attached to this center post and is raised or lowered easily by cranking the post up or down. These elevators eliminate the need for readjusting all three tripod legs for making small, last minute adjustments to the camera height.

Tripods come in a variety of designs, sizes, and weights (fig. 5-2). The heavier models are the sturdiest and provide the best support; however, if too heavy, they are not very portable. As a general rule, the heavier your camera, the heavier and stronger your tripod must be. For some of the light, full-size tripods, rigidity can be improved by hanging a bag of sand or another weight from the tripod head This is especially useful in high winds. Another method is to hang a strap from the tripod head, and use the strap as a foothold on which to apply downward pressure (fig. 5-3).

Tabletop tripods are also available and can be used almost anywhere a flat surface is available. These small tabletop tripods can even be braced against the photographer's chest. Because of their small size, they can easily be carried in a camera bag.

To set up a tripod, extend one leg straight ahead toward the subject. This way the camera may be aimed by pivoting the tripod on this one leg. Extend the other two legs and adjust them to level the tripod platform horizontally. When setting up a tripod on level ground, you can waste a lot of time trying to get the tripod level if the leg sections are not fully extended. An easy solution to the problem is to mark the tripod legs in specific increments with a marking pen, pencil, or scribe. One method is to mark short lines at l-inch intervals and long lines at 6-inch intervals. Doing this reduces your frustration, saves time, and allows you to level your camera on the tripod with less effort. When a tripod is set up on an uneven surface, several adjustments of the side legs are normally necessary. Readjustment of the front leg levels the camera vertically so the platform or head is level. Most newer tripods have platforms that can be adjusted by eliminating the need for minor leg adjustments.

To mount the camera on the tripod head, you secure it in place by tightening the tripod screw into the camera tripod socket. Secure the camera by tightening the camera clamp screw locknut. After the camera is mounted on the tripod, test the camera to ensure all camera controls are accessible and function properly. The camera should be stable and not shake when the camera controls are operated.



Courtesy of Bogan Photo Corp.
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Figure 5-2.–Tripods.

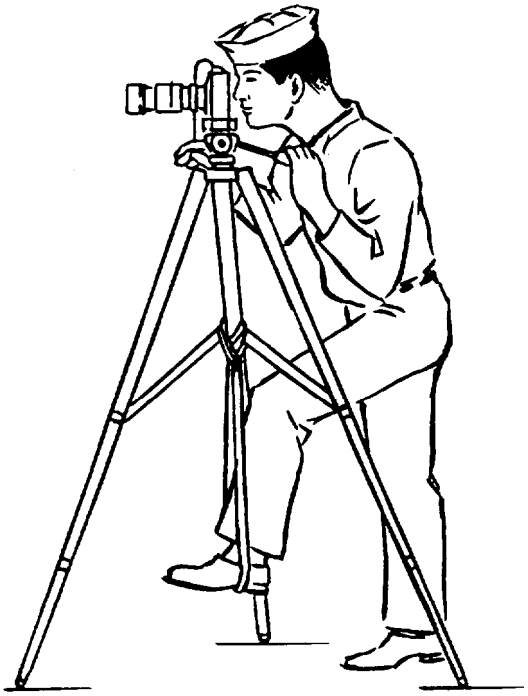


Figure 5-3.–Using a foot strap to make a tripod more rigid.



Figure 5-4.–Using a monopod.

Monopods

A monopod is a single pole on which a camera is mounted. Monopods are useful for keeping the camera steady for location work when a tripod is too bulky or difficult to use; however, the use of a monopod is not advisable when using large, heavy cameras or when shutter speeds below about 1/15 second are used. Standing or kneeling with a monopod braced against your body or leg provides a camera the extra support and steadiness required for it to be an effective tool (fig. 5-4).

Clamps

Another practical way to support your camera is to use one of the many clamps available for this purpose. A camera clamp has a mount that screws into the tripod hole or socket on the camera and has jaws that can be clamped to a convenient object. Camera support clamps can be attached to furniture, doors, posts, fences, and other firm anchor points. There are even clamps with suction cups for mounting cameras on smooth, flat surfaces, such as a window.

PHOTOGRAPHIC COMPOSITION

Photographic composition is *the pleasing arrangement of subject matter elements within the picture area.* Creative photography depends foremost on the photographer's ability to see as the camera sees because a photograph does not reproduce a scene quite the way we see it. The camera sees and records only a small isolated part of the larger scene, reduces it to only two dimensions, frames it, and freezes it. It does not discriminate as we do. When we look at a scene we *selectively* see only the important elements and more or less ignore the rest. A camera, on the other hand, sees all the details within the field of view. This is the reason some of our pictures are often disappointing. Backgrounds may be cluttered with objects we do not remember, our subjects are smaller in the frame or less striking than we recall, or the entire scene may lack significance and life.

Good pictures are seldom created by chance. To make the most of any subject, you must understand the basic principles of composition. The way you arrange the elements of a scene within a picture, catch the viewer’s attention, please the eye, or make a clear statement are all qualities of good composition. By developing photographic composition skills, you can produce photographs that suggest movement, life, depth, shape, and form, recreating the impact of the original scene.

How are photographic composition skills developed? You look, you study, you practice. Every time you take a picture, look all around within the viewfinder. Consider the way each element will be recorded and how it relates to the overall composition.

You must become thoroughly familiar with the camera and learn how the operation of each control alters the image. Experiment with the camera and look at the results carefully to see if they meet your expectations. With experience and knowledge of your equipment, you begin to "think through your camera" so you are free to concentrate on composition. Devote serious study to the principles of good composition. Study books and magazine articles on composition. You should analyze various media: motion pictures, TV, magazines, books and newspapers, and evaluate what you see. What is good about this picture or that TV image? What is bad about it? What principles of good composition could you apply in a different way to make the picture better.

Good or correct composition is impossible to define precisely. There are no hard-and-fast rules to follow that ensure good composition in every photograph. There are only the principles and elements that provide a means of achieving *pleasing* composition when applied properly. Some of these principles and elements are as follows:

- Center of interest
- Subject placement
- Simplicity
- Viewpoint and camera angle
- Balance
- Shapes and lines
- Pattern
- Volume
- Lighting
- Texture
- Tone
- Contrast
- Framing
- Foreground
- Background
- Perspective

As you study these principles of composition, you should soon come to a realization that some are very similar and overlap one another a great deal.

Because all or most of these principles must be considered and applied each time you take a picture, it may all seem quite confusing at first. With experience you can develop a sense of composition, and your consideration and application of the principles will become almost second nature. This is not to suggest that you can allow yourself to become complacent or careless in the application of the principles of composition. Doing so will be immediately obvious because the results you produce will be snapshots, not professional photographs.

The principles of composition that follow apply equally to both still and motion media photography.

CENTER OF INTEREST

Each picture should have only one principal idea, topic, or *center of interest* to which the viewer's eyes are attracted. Subordinate elements within the picture must support and focus attention on the principal feature so it alone is emphasized.

A picture without a dominant center of interest or one with more than one dominant center of interest is puzzling to a viewer. Subsequently, the viewer becomes confused and wonders what the picture is all about. When the picture has one, and only one, dominant "point of interest," the viewer quickly understands the picture.

NOTE: "Point of interest," as used here, has the same meaning as center of interest; however, using the term *point of interest* prevents giving the impression that the center of interest should be located in the center of the picture.

The specific topic, idea, or object to be portrayed must be set in your mind as you prepare to take a picture. When there is nothing in the picture to attract attention to a particular area or object, the eyes wander throughout the scene. The center of interest may be a single object or numerous ones arranged so attention is directed to one definite area

When the center of interest is a single object that fills most of the picture area or one that stands out boldly, such as a white sail against a background of dark water, attention is attracted immediately to it. As may be expected, not all subjects are as simple to arrange or as bold and impressive.

A photographer usually has at his or her disposal many factors or elements that can be used and arranged within the picture area to draw or direct attention to the primary idea of the picture. Some of these elements are lines, shapes, human figures, tone, and texture.

Human figures attract attention more strongly than almost any other subject matter and unless they are the

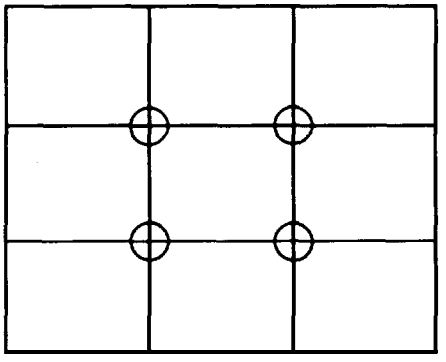


Figure 5-5.–Principle of thirds.

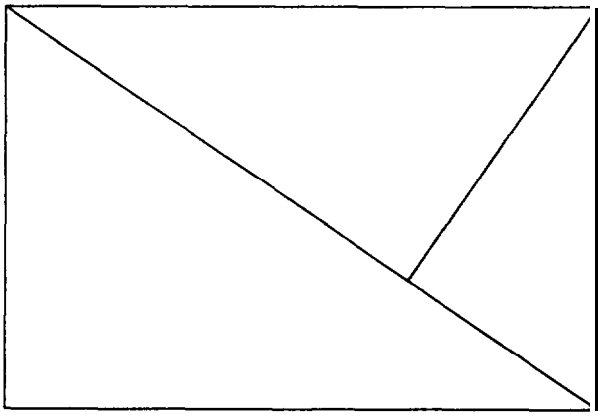


Figure 5-6.–Dynamic symmetry.

main object of the photograph should probably be kept out of the picture; for instance, a photograph showing a person standing at some distance in front of a building may leave the observer wondering whether the person or the building is the primary subject. When people are included in a scene for comparative size of objects or just for atmosphere, keep them from looking directly at the camera. When people look at the camera and therefore at the viewer of the picture, the viewer tends to return their gaze by looking directly back into their eyes. When they are not the intended point of interest, we miss the statement and purpose of the picture. When people are subordinate elements within the picture and they are looking in a direction other than at the camera, the viewer's attention is directed from the people to what *they are* looking at, which *should* be the center of interest; for example, when people are grouped around a piece of machinery that is the center of interest of the picture, have them look at the machine, rather than the camera.

SUBJECT PLACEMENT

Sometimes good composition is obtained by placing the center of interest in the geometrical center of the picture; it is generally not a good idea to place it there. Too frequently it divides the picture into equal halves and makes the picture uninteresting and difficult to balance. By dividing the picture area into thirds, both vertically and horizontally, and locating the center of interest at one of the intersections of the imaginary lines, you can usually create a feeling of balance to the composition (fig. 5-5).

In photographic composition there are two general guides for determining the best location for the center of interest. *The* first is the *principle of thirds. The* other is *dynamic symmetry*. In the principle of thirds, the intersection of lines that divide the picture area into thirds are marked by O's. These intersections are good locations for the center of interest in most photographs. Notice we said THE center of interest. Remember, have only one center of interest to a picture-keep it simple. The principle of dynamic symmetry is a similar idea. A good location for the center of interest is found by drawing or imagining a diagonal line from one corner to an opposite corner. Then, draw a second line perpendicular to the first from a third corner (fig. 5-6). The intersections of the lines are the location for the center of interest.

SIMPLICITY

Simplicity is the key to most good pictures. The simpler and more direct a picture is, the clearer and stronger is the resulting statement. There are several things to be considered when we discuss simplicity. First, select a subject that lends itself to a simple arrangement; for example, instead of photographing an entire area that would confuse the viewer, frame in on some important element within the area. Second, select different viewpoints or camera angles. Move around the scene or object being photographed. View the scene through the camera viewfinder. Look at the foreground and background. Try high and low angles as well as normal eye-level viewpoints. Evaluate each view and angle. Only after considering all possibilities should you take the picture. See beyond and in front of your subject. Be sure there is nothing in the background to distract the viewer's attention from the main point of the picture. Likewise, check to see there is nothing objectional in the foreground to block the entrance of the human eye into the picture.

A last point of simplicity-*tell only one story.* Ensure there is only enough material in the picture to convey

one single idea. Although each picture is composed of numerous small parts and contributing elements, none should attract more of the viewer's attention than the primary object of the picture. The primary object is the reason the picture is being made in the first place; therefore, all other elements should merely support and emphasize the main object. Do not allow the scene to be cluttered with confusing elements and lines that detract from the primary point of the picture. Select a viewpoint that eliminates distractions so the principal subject is readily recognized. When numerous lines or shapes are competing for interest with the subject, it is difficult to recognize the primary object or determine why the picture was made.

VIEWPOINT AND CAMERA ANGLE

The proper viewpoint or camera angle is an important factor in good composition. Repositioning your subject within the viewfinder frame and changing the camera viewpoint or camera angle are two simple ways of controlling composition.

Photographing from a different viewpoint or camera angle can often add drama and excitement or even bring out an unusual aspect of a subject. Most of the subjects you photograph are three-dimensional and should be photographed from an angle (to the right or left of and/or from higher or lower than the subject) that allows the viewer to see more than one side of the subject. The photographer should study the subject from different sides and angles. Walk around the subject and look at it from all viewpoints. See it from elevated and low positions as well as from eye level to find the best composition. This greatly assists in composing the subject for the best balance and helps to select a background that compliments, not distracts from the subject.

The terms *viewpoint* and *camera angle* are often used in conjunction with one another and sometimes used interchangeably. They can also have different meanings depending on how they are applied. Viewpoint" is the camera position in relationship to the subject. "Camera angle" is the angle in which the camera lens is tilted; for example, a picture of sailors marching, made from ground level with the camera held horizontal with reference to the ground, may be referred to as a "low viewpoint" (or camera position); however, when this picture is made, again from ground level, but with the camera pointed up, it may be referred to as a "low camera angle." Likewise, a picture made from an elevated or high position, with the camera again held horizontal with reference to the ground, or even pointed straight down, can be referred to as a "high viewpoint"; however, if the camera is not held horizontal to the ground or pointed straight down, but pointed at some angle between horizontal and vertical, the camera position could be referred to as a "high camera angle."

Eye-Level Shots

With the camera held horizontal, eye-level shots are usualIy made at a height of about 5 1/2 feet, the height from which the average adult sees, and with the camera horizontal. With the camera held at eye level but pointed up or down, the camera position changes and you have either a low or high camera angle, respectively.

Low Viewpoint and Low Camera Angle

Low viewpoints and low camera angles can add emphasis and interest to many ordinary photographs. A low viewpoint can be used to distort scale or add strength to a picture or to emphasize certain elements within the picture. A low camera angle is achieved when the camera angle is located below the point of primary interest and pointed upward. Low angles tend to lend strength and dominance to a subject and dramatize the subject. Low angle shots are used when dramatic impact is desired. This type of shot is very useful for separating the subject from the background, for eliminating unwanted foreground and background, and for creating the illusion of greater size and speed (fig. 5-7).

High Viewpoint and High Camera Angle

High viewpoints and high camera angles help orient the viewer, because they show relationships among all elements within the picture area and produce a psychological effect by minimizing the apparent strength or size of the subject (fig. 5-8).

BALANCE

Balance in photographic composition is a matter of making pictures look harmonious. Each element in a picture has a certain amount of value in respect to all the other elements. Every tone, mass, shape, tree, rock figure, building, line, or shadow contributes a certain amount of weight that must be arranged correctly in the composition to give the impression of balance. The subject placement within the picture area is the factor that must be carefully considered.

Composition is kept in balance by two different methods: symmetrical, or formal, balance and asymmetrical, or informal, balance.



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Figure 5-7.–Low viewpoint and low camera angle.

Symmetrical, or Formal, Balance

Symmetrical, or formal, balance in a photograph is achieved when elements on both sides of the picture are of equal weight (fig. 5-9A). The idea of formal balance can be related to a seesaw, When there are two equally weighted objects on the seesaw and they are equidistant from the pivot point, or fulcrum, the board will be in balance.

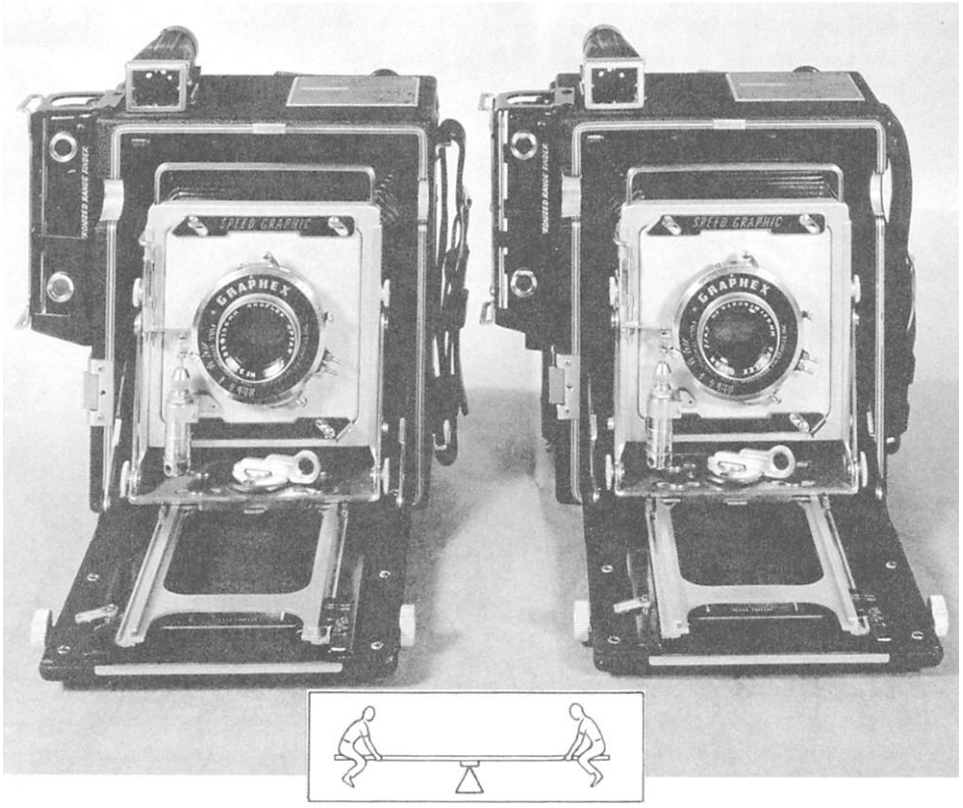
Pictures with formal balance may look static and unexciting; however, they do present an air of dignity.



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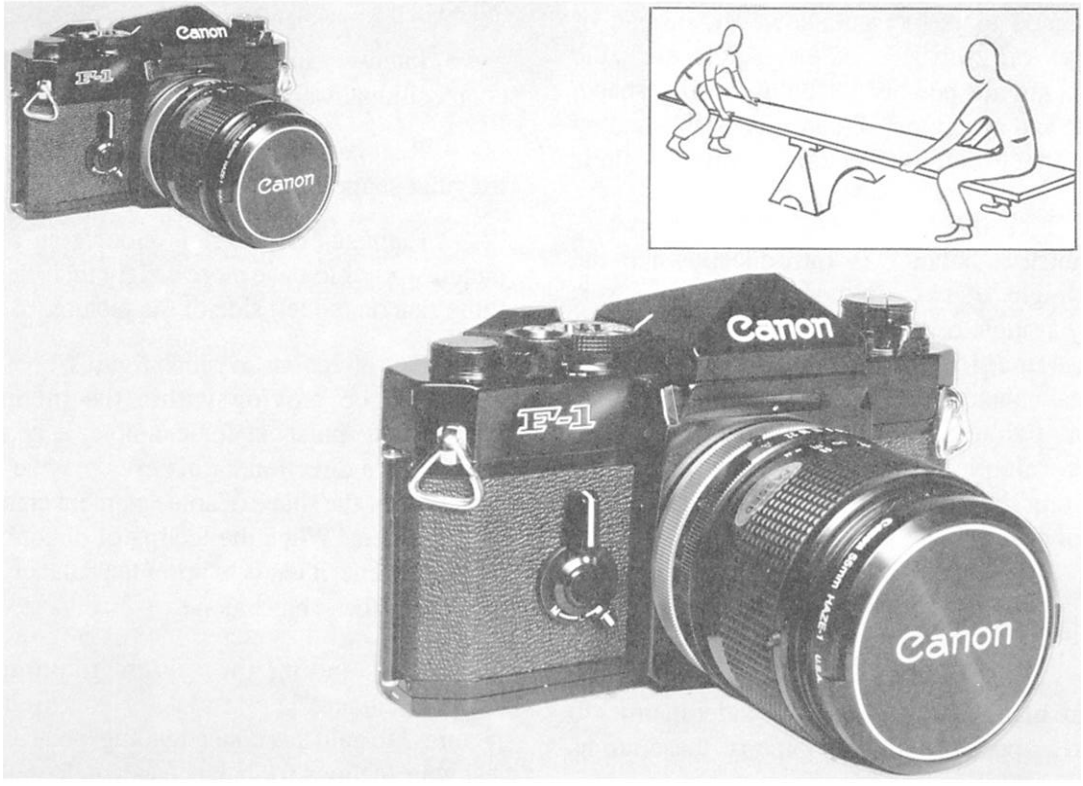
Figure 5-8.–High viewpoint and high camera angle.

Formal balance does not always mean a picture has to be symmetrical. Symmetrical pictures, in which both sides are exactly the same, are produced only when you want a special effect; therefore, they are not often produced. A variation of symmetrical balance deals with the seesaw in perspective. The forces or weights are presumed to be approximately equal; but, the imaginary pivot point is set deep into the picture space. With this variation to symmetrical balance, a more interesting photograph is usually created (fig. 5-9B).



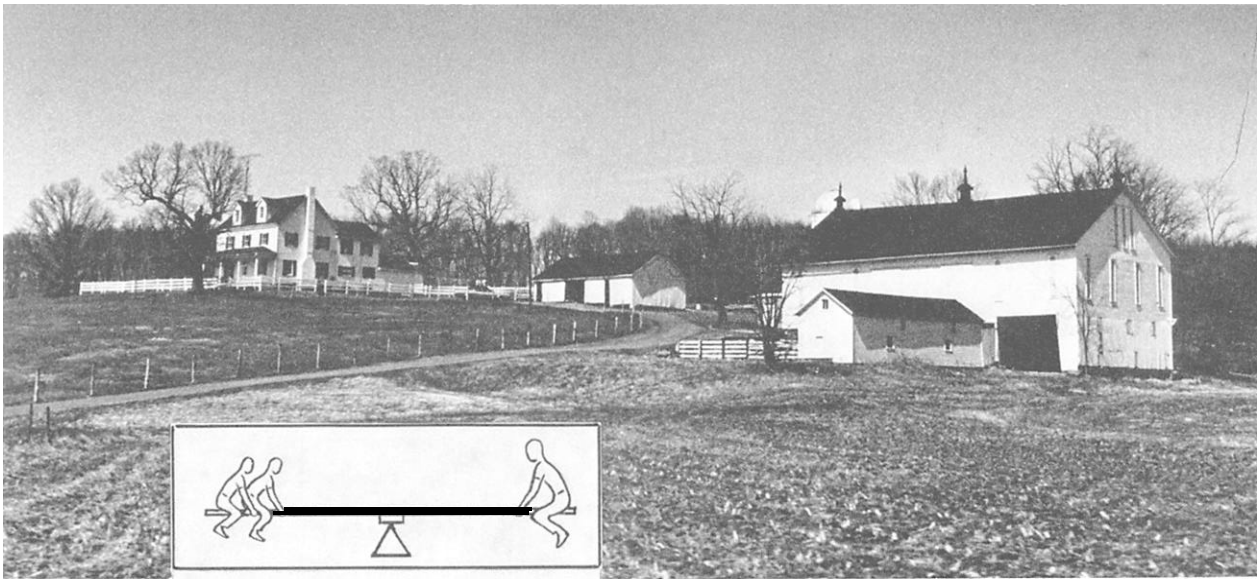
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Figure 5-9A.–Symmetrical, or formal, balance.



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Figure 5-9B.–Symmetrical, or formal, balance.



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Figure 5-10.–Asymmetrical, or Informal, balance.

Asymmetrical, or Informal, Balance

Asymmetrical, or informal, balance is usually much more interesting than symmetrical balance. In asymmetrical balance the imaginary central pivot point is still presumed to be present; however, instead of mirror images on each side of the picture area, the subject elements are notably different in size, shape, weight, tone, and placement. Balance is established by equalizing the element forces in spite of their differences.

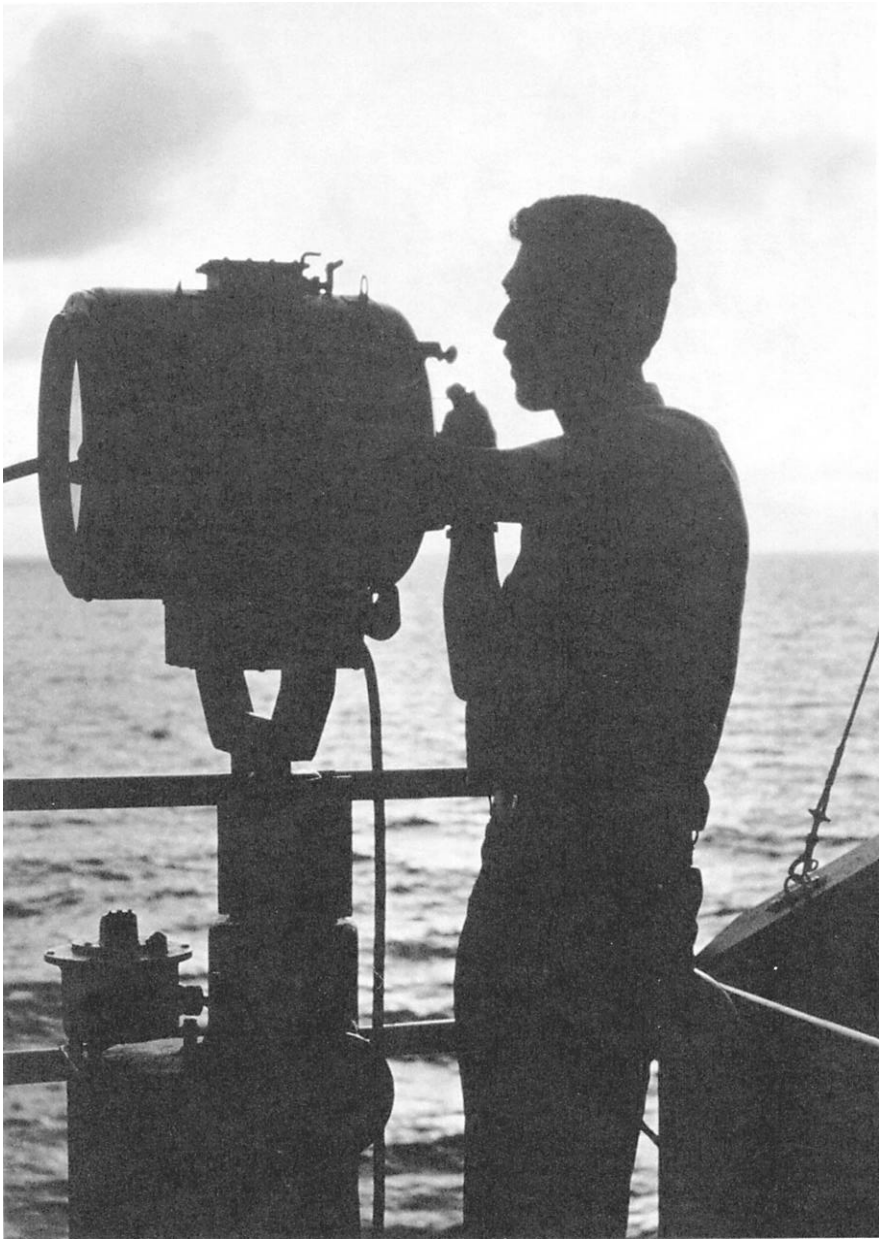
Asymmetrical balance is introduced when the presumed weight of two or more lighter objects is equalized by a single heavier object placed on the other side of the imaginary pivot point (fig. 5-10). Asymmetrical balance is more difficult to achieve than symmetrical balance, because of the problem of establishing relative weight values for dissimilar elements within the picture area as well as presenting some form of stability.

Aspects of Balance

There are many other factors to consider in order to make pictures appear balanced. Some of these are as follows:

- An object far from the center of the picture seems to have more weight than one near the center.
- Objects in the upperpart of a picture seem heavier than objects of the same size in the lower part of a picture.
- Isolation seems to increase the weight of an object.
- Intensely interesting objects seem to have more compositional weight.
- Regular shapes seem to have more weight than irregular shapes.
- Elements on the right side of an asymmetrical picture appear to have more weight than elements of the same size on the left side of the picture.
- The directions in which figures, lines, and shapes appear to be moving within the picture area are important to balance; for example, a person may be walking in a direction, or his eyes may be looking in a direction, or the shape of some element creates a feeling of movement. When the feeling of direction is present within a scene, it tends to upset the balance if judged on the size of the subject alone.

Understanding the factors required to create pictorial balance is essential for you to produce good pictures. To gain this understanding, you can continually test your feelings for balance as you look through your camera viewfinder. Once you gain an understanding of the principles of pictorial balance, achieving balance in your photographs becomes an easy process.



302.295

Figure 5-11.–Silhouettes emphasize shape.

SHAPES AND LINES

Shapes and lines are important elements in photographic composition. When properly used, shapes and lines can create a desired effect. As a photographer, you usually have control over the way shapes and lines are used in your pictures.

Shape

Shape is a two-dimensional element basic to picture composition and is usually the first means by which a viewer identifies an object within the picture. *Form* is the three-dimensional equivalent of shape. Even though shape is only two-dimensional, with the proper application of lighting and tonal range, you can bring out form and give your subjects a three-dimensional quality. Lighting can also subdue or even destroy form by causing dark shadows that may cause several shapes to merge into one.

Shapes can be made more dominant by placing them against plain contrasting backgrounds; for example, consider again the white sail against the dark water background. The greatest emphasis of shape is achieved when the shape is silhouetted (fig. 5-11), thus



PH1 Art Legare
302.296

Figure 5-12.–Leading lines.

eliminating other qualities of the shape, such as texture and roundness, or the illusion of the third dimension.

Lines

Lines can be effective elements of composition, because they give structure to your photographs. Lines can unify composition by directing the viewer's eyes and attention to the main point of the picture or lead the eyes from one part of the picture to another. They can lead the eyes to infinity, divide the picture, and create patterns. Through linear perspective, lines can lend a sense of depth to a photograph. (Linear perspective causes receding parallel lines to appear to converge in the picture. This allows you to create an illusion of depth in your pictures.)

The viewer's eyes tend to follow lines into the picture (or out of the picture) regardless of whether they are simple linear elements such as fences, roads, and a



PH2(AC) Mark Kettenhofen
302.297

Figure 5-13.–Diagonal lines convey a feeling of dynamic action.

row of phone poles, or more complex line elements, such as curves, shapes, tones, and colors. Lines that lead the eye or direct attention are referred to as *leading lines.* A good leading line is one that starts near the bottom corner of the scene and continues unbroken until it reaches the point of interest (fig. 5-12). It should end at this point; otherwise, attention is carried beyond the primary subject of the photograph. The apparent direction of lines can often be changed by simply changing viewpoint or camera angle.

Vertical, diagonal, horizontal, and curved lines create different moods. Vertical lines communicate a sense of strength, rigidity, power, and solidarity to the viewer. On the other hand, horizontal lines represent peace, tranquillity, and quietness. A generally accepted practice is to use a vertical format for pictures having predominantly vertical lines and horizontal format for pictures having predominantly horizontal lines. Again, this is a *generally accepted practice,* NOT *a rule.*

Diagonal lines represent movement, action, and speed. A picture with diagonal lines conveys a feeling of dynamic action even when the subject is static (fig. 5-13). Curved lines present a sense of grace,



PH2 Frazier
302.298

Figure 5-14.–Use of curved lines in photographic composition.

smoothness, and dignity to a photograph (fig. 5-14). The most common curved line is the S curve.

Lines are not only present in the shape of things but can be created by arranging several elements within the picture area so they form lines by their relationship with one another.

PATTERN

Creating your pictures around repeating elements or patterns provides picture unity and structure. Pattern repetition creates rhythm that the eyes enjoy following (fig. 5-15). When lines, shapes, and colors within a picture occur in an orderly way (as in wallpaper), they create patterns that often enhance the attractiveness of photographs. Pattern, like texture, is found almost everywhere. It can be used as the primary subject but is most often used as a subordinate element to enhance composition. When pattern is used as a supporting element, it must be used carefully so it does not confuse or overwhelm the viewer. Pictures that are purely pattern are seldom used, because they tend to be monotonous. Patterns should be used to strengthen and add interest to your subject.

Shape is the most common and powerful pattern element. Repeated lines, tone, and color can also provide unity to your composition and combinations of these create interesting pictures. Triangles, squares, and circles are the basic shapes to look for in a pattern. Triangles and squares are usually static but can be placed to create a tension-filled, dynamic effect. Circles and curves are pleasing pattern shapes.

VOLUME

When photographing most subjects, you face the problem of how to symbolize three-dimensional objects in a two-dimensional picture. The solution becomes



PHAN A. J. Seely
302.299

Figure 5-15.–Shapes used in composition.

simple when a distinction is made between the two different ways three-dimensional objects appear: as positive, or occupied space (volume) or as negative, or unoccupied space.

If you make a picture to show the entire machine shop aboard a repair ship using only one powerful flash unit placed at the camera, you only *symbolize* empty or negative space; however, a sense of depth is provided because of increasing darkness toward the back of the shop. Occupied or positive space (the machines) is front-lighted and appears shadowless and flat. On the other hand, if you use a series of lights along the sides

of the machine shop to sidelight the machines, shadows are cast at their sides and occupied or positive space appears three-dimensional; however, since all the machines, both near and far, are now lighted the same, you do not create a sense of depth, and empty or negative space appears flat. For the best picture of the machine shop, you should light the machines in a way that the three-dimensional form is represented, while creating a sense of depth by reducing the intensity of illumination toward the back of the shop.

LIGHTING

Lighting is also an important creative element of composition. By controlling the light and directing it where you want it, you can subdue objects or distracting elements in the scene to give more emphasis to the main point of interest.

For good picture composition, you must develop an awareness of how changes in lighting can affect the appearance of things around you. Light and shadows can be used in composition to create mood, to draw attention to an area, to modify or distort shape, or to bring out form and texture in the subject.

Shadows are a key to apparent form in photographs. Without shadows, the subject records without form, curvature, or texture, appearing flat and lifeless. This does not mean that shadows must be harsh and black to achieve the effects of form, curvature, and texture. They may be soft, yet of sufficient density to show the most delicate roundness and form. Generally, harsh, black shadows are undesirable in a photograph due to the loss of detail in them. From a compositional standpoint, black shadows can be very useful in balancing a scene and directing attention to the point of interest. Harsh shadows can also be excellent for emphasizing texture and form, for creating interesting patterns, and for directing attention to the main point of interest; however, the same elements can also obscure detail and reduce form. When the lighting is harsh, such as on a clear, sunny day, shadows have sharply defined edges and are probably very dark, sometimes to the point that they appear stronger than the primary subject and attract attention to themselves.

TEXTURE

Texture helps to emphasize the features and details in a photograph. By capturing “texture” of objects being photographed, you can create form.

When people observe a soft, furry object or a smooth, shining surface, they have a strong urge to touch it. You can provide much of the pleasure people get from the feel of touching such objects by rendering texture in your pictures. Texture can be used to give realism and character to a picture and may in itself be the subject of a photograph. When texture is used as a subordinate element within the picture, it lends strength to the main idea in the photograph. It usually takes just a little different lighting or a slight change in camera position to improve the rendering of texture in a picture. When an area in a photograph shows rich texture, the textured area usually creates a form or shape; therefore, it should be considered in planning the photograph (fig. 5-16).

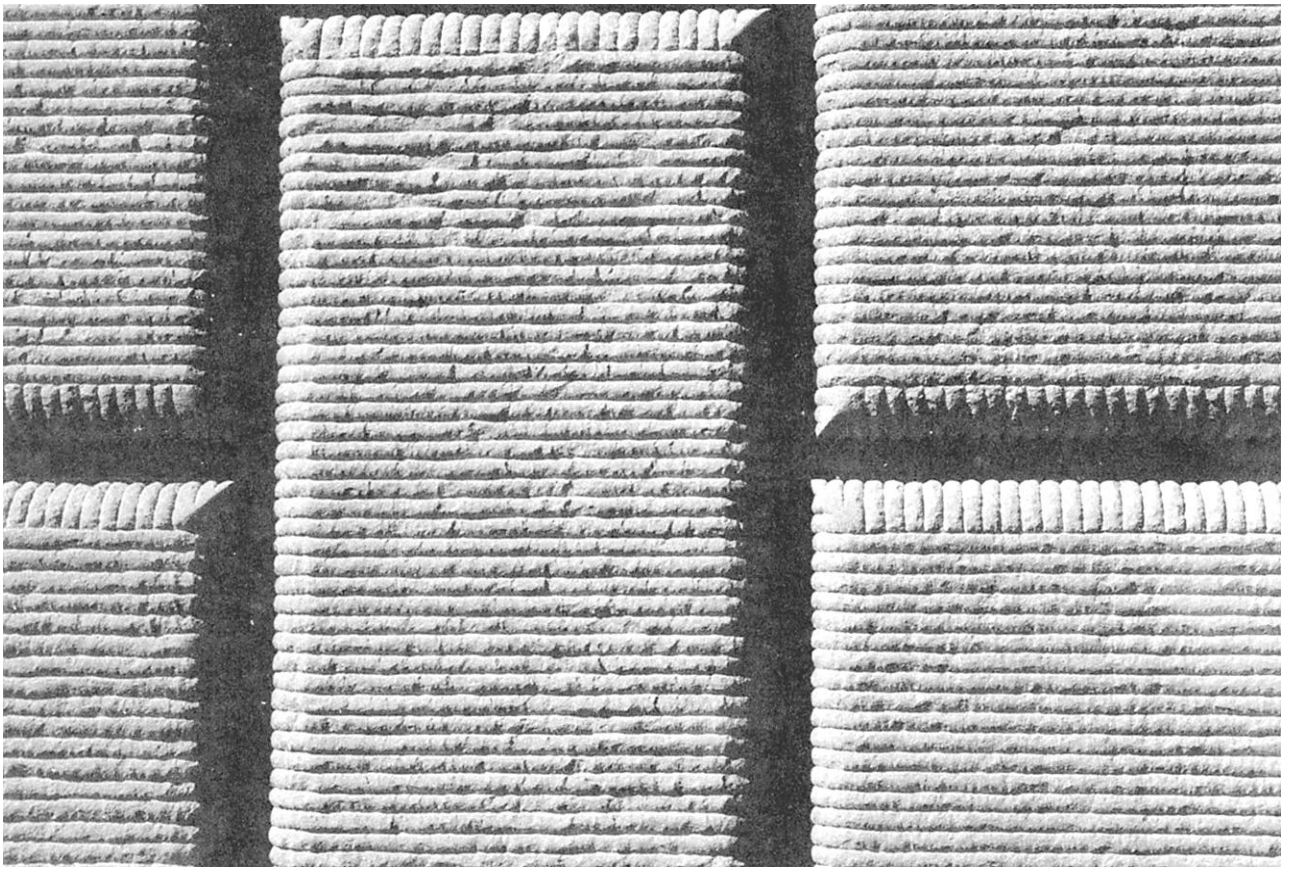
TONE

Tone is probably the most intangible element of composition. Tone may consist of shadings from white-to-gray-to-black, or it may consist of darks against lights with little or no grays. The use of dark areas against light areas is a common method of adding the feeling of a third dimension to a two-dimensional black-and-white picture. The interaction of light against dark shades in varying degrees helps to set the mood of a composition. A picture consisting of dark or somber shades conveys mystery, intrigue, or sadness. When the tones are mostly light and airy, the picture portrays lightness, joy, or airiness.

CONTRAST

Contrast in photographic composition is an effective means of directing the viewer's attention to the center of interest. Positioning of subject elements to create contrast gives them added emphasis and directs the viewer's attention.

When we speak of contrast as it relates to composition, we are referring to both tonal contrast, as in black-and-white photography, and color contrast as it relates to color photography. In black-and-white photography, contrast is the difference in subject tones from white-to-gray-to-black or from the lightest tone to the darkest tone. In color photography different colors create contrast.



PH2 J. Finnigan
302.300

Figure 5-16.–Photograph emphasizing texture.

Tonal Contrast

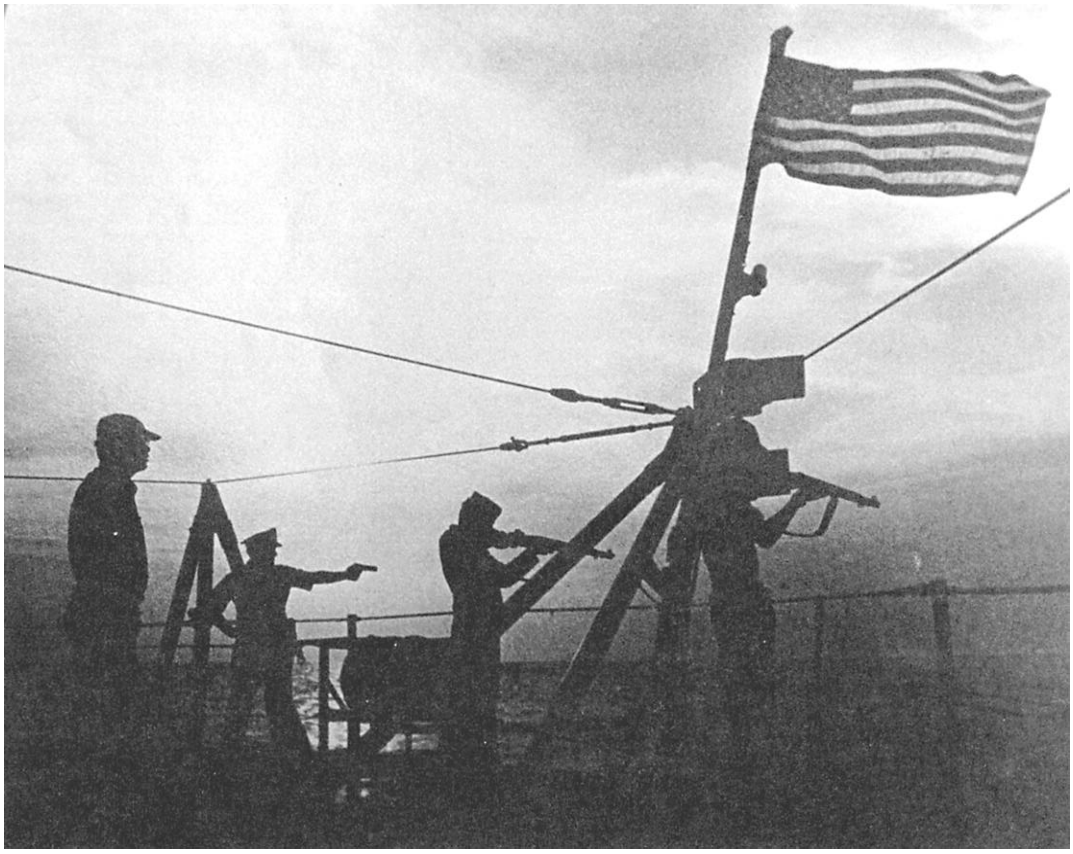
In black-and-white photography, contrast is considered either *high, normal,* or *low.* A high-contrast scene or photograph consists primarily of white and black with few or no middle gray tones. A black sailor in a white uniform against a light background is an example of a high-contrast (contrasty) scene. Most scenes you photograph have normal contrast. There will probably be elements within the scene that are very light or white, some that are very dark or black, and many tones or colors that reproduce as various tones of gray. A low-contrast (flat) scene has colors or tones in which highlights and shadows have very little difference in densities. In other words, all colors or tones within the scene are very similar in appearance. A white sailor in a white uniform against a light background is an example of a scene with low contrast.

In black-and-white photography, high contrast conveys a sense of hardness and is characteristic of strength and power. Low contrast conveys a sense of softness and is characteristic of gentleness and mildness.

Color Contrast

Color contrast is an effective compositional element in color photography, just as tone is in black-and-white photography. Colors with opposite characteristics contrast strongly when placed together. Each color accentuates the qualities of the other and makes the color images stand out dramatically. Color contrast is enhanced when you create the contrast of detail against mass. An example is a single, bright, red flower in a clear, glass vase photographed against a bright, green background.

Cold colors (bluish) and warm colors (reddish) almost always contrast. Cold colors recede, while warm colors advance. Light colors contrast against dark ones, and a bold color offsets a weak color.



PH2 Neil Crews
302.301

Figure 5-17.–Low-key scene.

LOW- AND HIGH-KEY SCENES.–When a scene contains mostly dark tones or colors, it is low key (fig. 5-17). When the scene contains mostly light tones, it is high key (5-18). Low-key and high-key pictures convey mood and atmosphere. Low key often suggests seriousness and mystery and is often used in horror pictures, such as a dark-granite castle in a thunderstorm. High key creates a feeling of delicacy and lightness. A photograph of a fair-skinned, blond-haired mother dressed in a white gown against a light background nursing her baby is a good subject for a high-key picture.

HIGH- AND LOW-KEY COLORS.–High-key color pictures contain large areas of light desaturated colors (pastels) with very few middle colors or shadows. Intentionally overexposing color film (exposing for the shadows) helps to create a high-key effect.

A low-key effect is created when the scene is dominated by shadows and weak lighting. Low-key pictures tend to have large areas of shadow, few highlights, and degraded colors. Naturally dark subjects are best for low-key pictures. Low-key color pictures can be induced by exposing color film for the highlights.

FRAMING

Framing is another technique photographers use to direct the viewer's attention to the primary subject of a picture. Positioned around the subject, a tree, an archway, or even people, for example, can create a frame within the picture area. Subjects enclosed by a frame become separated from the rest of the picture and are emphasized. Looking across a broad expanse of land or water at some object can make a rather dull uninteresting view. Moving back a few feet and framing the object between trees improves the composition.

An element used as a frame should not draw attention to itself. Ideally, the frame should relate to the theme of the picture; for example, a line of aircraft parked on the flight line framed by the wing and prop of another aircraft.

Not only is framing an effective means of directing the viewer's attention, it can also be used to obscure undesirable foregrounds and backgrounds. The illusion of depth can be created in a picture by the effective use of framing (fig. 5-19).



JOC Guy Miller
302.52

Figure 5-18.–High-key scene.



PH1 Michael D.P. Flynn
302.302

Figure 5-19.–Framing used in photographic composition.



PH3 Tim O'Neill
302.95

Figure 5-20.–Blurred background creates subject separation.

FOREGROUND

A large percentage of otherwise good pictures is ruined, because they include unnecessary or distracting foreground. This common fault can result from the photographer standing too far away from their subject when they *take* a picture, or the fact that normal focal length or standard lenses cover a relatively wide angle of view.

Undesirable foreground can be eliminated by moving in closer to the subject, by making pictures with a longer than standard focal-length lens, or by changing viewpoint or camera angle. Many already existing pictures can be improved by enlarging only a section of the negative and by cropping out meaningless or distracting foreground. In most cases, the foreground should be sharply focused and of sufficient depth to furnish substantial support for the subject. No object in the foreground should ever be so prominent that it distracts from the subject. You should clear the foreground of items that have no connection with the picture. The ultimate example of carelessness on the part of the photographer is to leave his or her camera case where it shows in the picture. Generally, the foreground contains the leading line that is the line that leads the eye into the photograph and toward the point of interest. Whether this line is an object or series of objects or shadows, it should be sharply focused. A fuzzy, out-of-focus foreground usually irritates the senses and detracts from emphasis on the subject matter.

BACKGROUND

The background is almost as important an element in good composition as the camera angle. Too often it is overlooked when composing a scene since the photographer normally gives so much attention to the subject. Be particularly observant of the background to see that it contains nothing distracting. A tree or pole that was unnoticed in the distance behind a person when composing the scene may appear in the photograph to

be growing out of his or her collar or supporting his or her head.

The background should be subordinate to the main subject in both tone and interest. It should also make the subject stand out and present it to best advantage. Unsharpness and blur are effective ways for separating the subject from the background. Unsharpness can be accomplished by using a relatively large f/stop to render the background out of focus. In the case of subjects in motion, the subject can be pictured sharply and the background blurred by panning the subject (fig. 5-20). Occasionally, you may want to reverse these effects and record the subject unsharp or blurred and the background sharp. This is done to create the impression of the subject being closer to the viewer or to express motion by holding the camera still as you use a shutter speed that is too slow to "stop" the motion.

PERSPECTIVE

Perspective refers to the relationship of imaged objects in a photograph. This includes their relative positions and sizes and the space between them. In other words, perspective in the composition of a photograph is the way real three-dimensional objects are pictured in a photograph that has a two-dimensional plane. In photography, perspective is another illusion you use to produce photographs of quality composition.

When you are making pictures, the camera always creates perspective. Because a camera automatically produces perspective, many novice photographers believe there is no need to know much about it. This attitude is far from correct. When you know the principles of perspective and skillfully apply them, the photographs you produce show a good rendition of the subject's form and shape, and the viewer is given the sensation of volume, space, depth, and distance. Additionally, the photographer can manipulate perspective to change the illusion of space and distance by either expanding or compressing these factors, therefore providing a sense of scale within the picture.

Linear Perspective

The human eye judges distance by the way elements within a scene diminish in size, and the angle at which lines and planes converge. This is called *linear perspective.*

The distance between camera and subject and the lens focal length are critical factors affecting linear perspective. This perspective changes as the camera position or viewpoint changes. From a given position, changing only the lens focal length, and not the camera position, does not change the *actual* viewpoint, but may change the *apparent* viewpoint.

The use of different focal-length lenses in combination with different lens-to-subject distances helps you alter linear perspective in your pictures. When the focal length of the lens is changed but the lens-to-subject distance remains unchanged, there is a change in the image size of the objects, but no change in perspective. On the other hand, when the lens-to-subject distance and lens focal length are both changed, the relationship between objects is altered and perspective is changed. By using the right combination of camera-to-subject distance and lens focal length, a photographer can create a picture that looks deep or shallow. This feeling of depth or shallowness is only an illusion, but it is an important compositional factor.

Using a short-focal-length lens from a close camera-to-subject distance, or viewpoint, produces a picture with greater depth (not to be confused with depth of field) than would be produced with a standard lens. Conversely, using a long-focal-length lens from a more distant viewpoint produces a picture with less apparent depth.

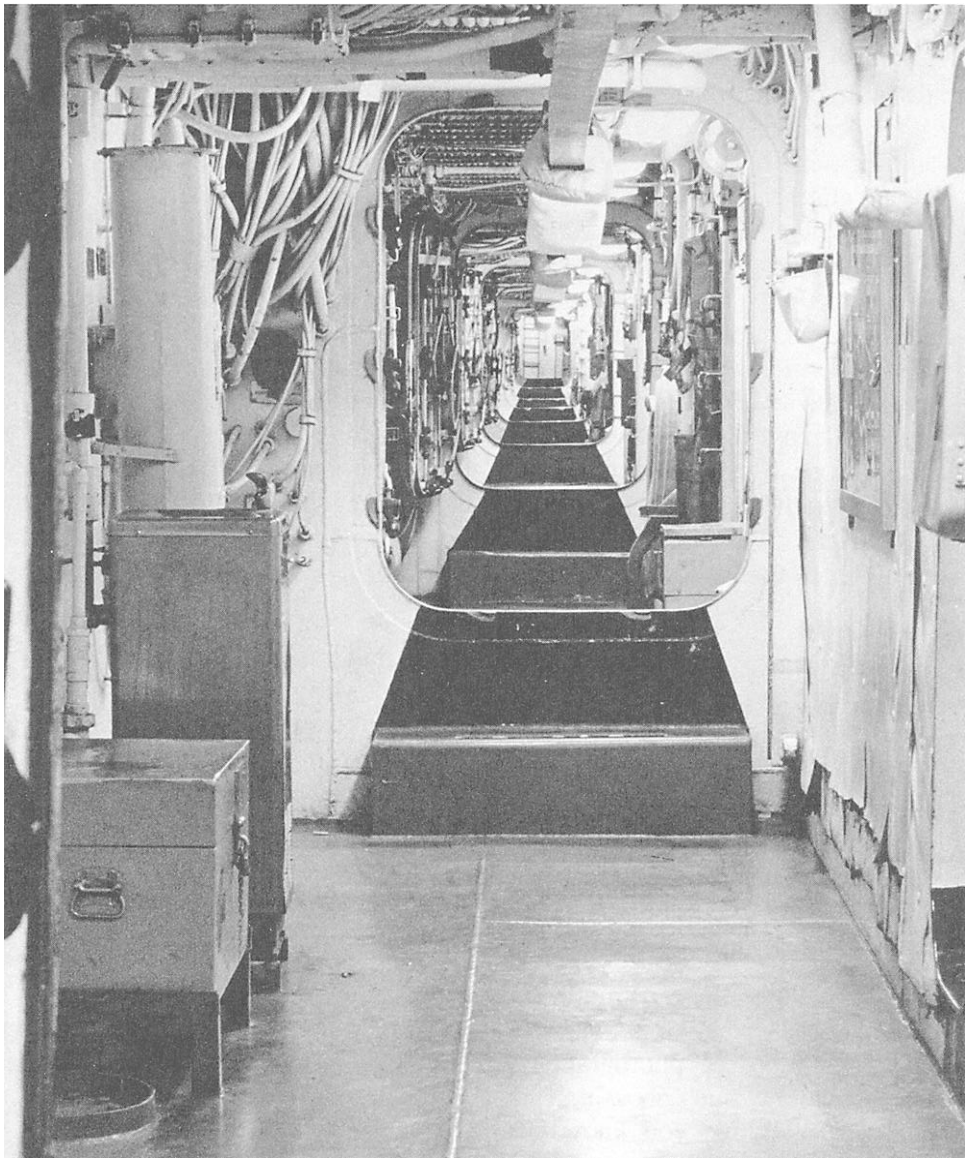
Rectilinear Perspective

Most lenses produce rectilinear perspective that are typical of what the human eye sees. This is to say that lines that are straight in the subject are reproduced straight in the picture. Most pictures are made with rectilinear lenses.

Fisheye lenses and the lenses used on panoramic cameras produce a false perspective. A panoramic lens produces panoramic or cylindrical perspective. In other words, all straight horizontal lines at the lens axis level are recorded as straight lines, and all other straight horizontal lines either above or below the lens axis level are reproduced as curved lines. The other false perspective is produced by a fisheye lens in which all straight lines in the subject are imaged as curved lines toward the edges of the picture.

Vanishing Point Perspective

In vision, lines that are parallel to each other give the sensation of meeting at vanishing points. When parallel lines, either horizontal or vertical, are *perpendicular* to the lens axis, the vanishing points are assumed to be at infinity. Other lines, those which are *parallel* to the lens axis, and all other parallel lines at all other angles to the lens axis meet at definable vanishing



PHC Jeff Hilton
302.303

Figure 5-21.–Vanishing point perspective.

points. Thus lines that are parallel to the lens axis, or nearly parallel, start in the front of the picture and meet at vanishing points within the picture or at finite points outside the picture (fig. 5-21).

Height Perspective

The place where the base of an object is located on the ground in a picture is a clue to its distance from the camera viewpoint; for example, in a landscape scene, the ground or ground plane rises toward the horizon. The higher up in the ground area of the picture (up to the horizon) that the base of an object is located, the further away it seems from the viewpoint and the greater its height perspective.

Overlap Perspective

Another clue to distance in a photograph is overlap perspective. When subjects within the picture are on about the same line of sight, those objects closer to the camera viewpoint overlap more distant objects and partially hide them. It is obvious to the viewer that the partially obstructed object is behind the unobstructed object. This overlap is repeated many times within the picture and gives the viewer a sense of depth and a perception of the relative distance of objects.



PH3 Joan Zopf
302.304

Figure 5-22.–Dwindling size perspective.

Dwindling Size Perspective

Through the experience of vision, you are aware of the size of many common objects, such as people, trees, cars, buildings, and animals; for example, you are aware that most adults are about 5 to 6 feet tall; therefore, when two people are shown in a picture and one appears twice as tall as the other, you cannot assume that one is in reality taller than the other. Instead you assume the taller person is closer and the shorter person farther away from the camera viewpoint. In this same manner, you make a size relationship evaluation of all familiar objects. Thus you can make a distance determination from this size relationship evaluation. The farther away an object is from the viewpoint, the smaller it appears; therefore, when subjects of familiar size are included in a photograph, they help to establish the scale of the picture (fig. 5-22). Scale helps the viewer determine or visualize the actual size or relative size of the objects in the picture.

Volume Perspective

When a subject is lighted with very diffised light, the three-dimensional form or volume of the subject is difficult to perceive because of the lack of distinct shadows. If, on the other hand, subjects are lighted with strong directional light from angles that cause part of the subject to be fully lighted and other parts to be in shadow, a visual clue of the subject's form or volume is provided When a number of such objects are included within the picture area, the perception of form, volume, and depth is increased. When front or side lighting is used, the length, depth, and shape of the shadows cast on the ground provide a perspective of each object's volume. Also, the distance between shadows cast on the



302.305

Figure 5-23.–Atmospheric perspective.

ground helps you to perceive the overall depth of the scene.

Atmospheric Perspective

For all practical purposes, air is transparent. For most photography, this is fundamentally true; however, when pictures are made of subjects at great distances, the air is actually less than fully transparent. This is because air contains very fine particles of water vapor, dust, smoke, and so on. These particles scatter light and change its direction. The presence of scattering shows distant subjects in pictures as having a veil or haze. The appearance or effect of this scattering is proportional to the distance of the objects from the viewpoint. The greater the distance, the greater the amount of veiling or haze (fig. 5-23). The effects of this scattering of light are additive, but vary with atmospheric conditions.

In atmospheric perspective several factors must be considered:

- Contrast–The luminance of each object in a scene is a direct result of the objects reflective quality and the amount of light falling on it. When objects are far away, light from highly reflective objects is scattered; therefore, when viewed from a distance (or imaged on a print), the darker portions of these distant objects do not appear as dark and the contrast is reduced. When there are objects both near and far from the camera, the difference in contrast provides a perception of distance.

- Brightness–The particles in air that scatter light are also illuminated by the sun. This causes an increase in the overall brightness of the objects seen. This increase in luminance, coupled with a loss of contrast, causes objects in the distance to be seen and

photographed as lighter in color than they would be at a closer distance.

- Color saturation–The scattering of light not only affects contrast and brightness but also color saturation.

Color is defined by three qualities: *hue* (the actual wavelength), *saturation* (intensity or chroma), and brightness (reflective). A pure hue is fully saturated or undiluted. When a hue is desaturated or diluted, it is no longer pure but has gray intermingled with it. The actual colors of a distant scene appear to have less color saturation, because the light is scattered and also because of the overall presence of the desaturated (diluted) blue light of aerial haze. The original scene colors appear less saturated or pure when seen or photographed from a distance than from close-up; therefore, color saturation or desaturation allows the viewer to perceive distance in a color photograph.

- Sharpness–Because of atmospheric haze, there is a loss of image sharpness or definition in distant objects. This loss of sharpness is caused both by the lowering of contrast and the scattering of light. The loss of sharpness contributes to a sense of distance. This can be enhanced by setting the far limit of the lens depth of field just short of infinity. This procedure throws the most distant objects slightly out of focus. This combined with the other effects of aerial perspective intensities the sense of distance.

PHOTOGRAPHIC LIGHTING

In this discussion of lighting, the basic lighting techniques used by photographers are presented. Lighting used primarily with a certain segment of photography, such as motion picture, TV, portrait, and studio, are discussed in the chapters relevant to that particular subject.

OUTDOOR LIGHTING

As a photographer, you work with light to produce quality pictures. The color, direction, quantity, and quality of the light you use determines how your subjects appear. In the studio, with artificial light sources, you can precisely control these four effects; however, most of the pictures you make are taken outdoors. Daylight and sunlight are not a constant source, because they change hourly and with the weather, season, location, and latitude. This changing daylight can alter the apparent shapes, colors, tones, and forms of a scene. The color of sunlight changes most rapidly at the extreme ends of the day. Strong color changes also occur during storms, haze, or mist and on blue wintery days. The direction of light changes as the sun moves across the sky. The shape and direction of shadows are altered, and the different directions of sunlight greatly affect the appearance of a scene.

The quality of sunlight depends on its strength and direction. Strong, direct sunlight is “hard” because it produces dark, well-defined shadows and brilliant highlights, with strong modeling of form. Sunlight is hardest on clear summer days at noon. Strong sunlight makes strong colors more brilliant, but weak colors pale. Sunlight is diffused by haze, mist, and pollution in the air. This diffused or reflected light is softer; it produces weak, soft shadows and dull highlights. Directionless, diffused sunlight is often called “flat” lighting because it produces fine detail but subdues or flattens form. Weak, directionless sunlight provides vibrant, well-saturated colors.

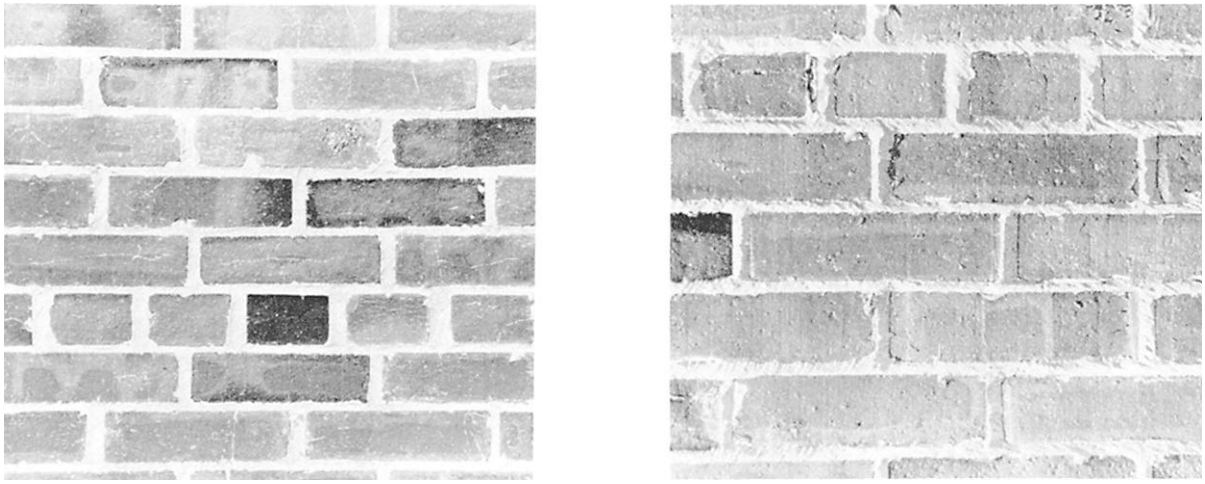
Frontlighting

The old adage about keeping the sun at your back is a good place to continue our discussion of outdoor lighting. The type of lighting created when the sun is in back of the photographer is called frontlighting. This over-the-shoulder lighting was probably the first photographic advice you ever received. This may seem to be a universal recipe for good photography. But it is not. The case against over-the-shoulder lighting is it produces a flattened effect, doing nothing to bring out detail or provide an impression of depth. The human eye sees in three dimensions and can compensate for poor lighting. A photograph is only two-dimensional; therefore, to give an impression of form, depth, and texture to the subject, you should ideally have the light come from the side or at least at an angle.

Side Lighting

As you gain experience with various types of outdoor lighting, you discover that interesting effects can be achieved by changing the angle of the light falling on your subject. As you turn your subject, change the camera viewpoint, or wait for the sun to move, the light falls more on one side, and more shadows are cast on the opposite side of the subject. For pictures in which rendering texture is important, side lighting is ideal.

Look at a brick wall, first in direct front sunlight and then in side lighting. Direct, front sunlight shows the pattern of the bricks and mortar in a flat, uninformative



PHC Ron Bayles
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Figures 5-24.–Comparison of front and side lighting.

way, but side lighting creates shadows in every little crevice (fig. 5-24). The effect increases as the light is more parallel with the wall until long shadows fall from the smallest irregularity in the brickwork This can give an almost 3-D effect to a photograph.

Side lighting is particularly important with black-and-white photography that relies on gray tones, rather than color, to record the subject. Shadows caused by side lighting reveal details that can create striking pictures from ordinary objects that are otherwise hardly worth photographing in black and white. Anything that has a noticeable texture-like the ripples of sand on a beach, for example-gains impact when lit from the side. Landscapes, buildings, people, all look better when sidelighted.

This applies to color photography as well. Color gives the viewer extra information about the subject that may make up for a lack of texture in frontlighting, but often the result is much better when lit from the side.

Pictures made with side lighting usually have harsh shadows and are contrasty. To lighten the shadows and reduce the contrast, you may want to use some type of reflector to direct additional skylight into the shadow areas or use fill-in flash, whichever is more convenient.

Backlighting

When the sun is in front of the photographer, coming directly at the camera, you have what is referred to as backlighting; that is, the *subject* is backlit. This type of lighting can be very effective for pictures of people outdoors in bright sunlight. In bright sunlight, when subjects are front-lighted or even sidelighted, they may be uncomfortable and squint their eyes. Backlighting helps to eliminate this problem. Backlighting may also require the use of a reflector or fill-in flash to brighten up the dark shadows and improve subject detail. Backlighting is also used to produce a silhouette effect.

When you use backlighting, avoid having the sun rays fall directly on the lens (except for special effects). A lens hood or some other means of shading the lens should be used to prevent lens flare.

EXISTING LIGHT

Existing light photography, sometimes called available or natural light photography, is the making of pictures by the light that happens to be on the scene. This includes light from table, floor, and ceiling lights, neon signs, windows, skylights, candles, fireplaces, auto mobile headlights, and any other type of light that provides the natural lighting of a scene-except daylight outdoors. (Moonlight is considered existing light.) Existing light then is that type of light found in the home, in the office, in the hangar bay, in the chapel, in the club, in the sports arenas, and so on. Outdoor scenes at twilight or after dark are also existing light situations.

Photography by existing light produces pictures that look natural. Even the most skillfully lighted flash picture may look artificial when compared to a good existing light photograph. With existing light photography, the photographer has an opportunity to make dramatic, creative pictures. Existing light allows the photographer greater freedom of movement because

extra lighting equipment is not required. Subject distance, when not using flash, has no effect on exposure; therefore, you can easily photograph distant subjects that could not otherwise be photographed using flash or some other means of auxiliary lighting. With existing light, you can make pictures that could not be taken with other types of lighting; for example, flash may not be appropriate during a change of command ceremony or chapel service. Not only can the flash disturb the proceedings, but it may not carry far enough to light the subject adequately.

For existing light pictures, your camera should be equipped with a fast lens-at least f/2.8, but preferably about f/1.4. The camera shutter should have a B or T setting, and for exposures longer than about 1/60 second, you need a tripod or other means of supporting the camera.

Because the level of illumination for many existing light scenes is quite low, you may want to consider using a high-speed film. When making pictures with plenty of existing light or when you particularly want long exposures for special effect, you can use a slower film; however, the advantages of high-speed film are as follows:

- Allows you to get adequate exposure for hand-held shots.
- Allows you to use faster shutter speeds to reduce camera and image motion.
- Permits the use of longer focal-length lenses when the camera is hand-held.
- Allows the use of smaller f/stops for greater depth of field.

When you are making existing-light color pictures indoors of scenes illuminated by tungsten light, use a tungsten type of film. When the light for your indoor color pictures is daylight from a window or skylight, use a daylight type of color film or use tungsten film with a No. 85B filter. Always use an exposure meter to calculate your indoor existing light exposure. When a bright window is included in the background, take a closeup meter reading of the subject to prevent the meter from being overly influenced by light from the window.

Pictures made indoors by existing daylight are pleasing to the viewer, because of the soft diffused light and the squint-free expression of your subjects. Open all the window drapes in the room to get the highest level of illumination possible. Pose your subject to allow diffused daylight to fall on the front or side of their face. Try not to pose your subject in a position where too much of the facial features are in shadow, unless you are trying for a special effect, such as a silhouette. When you photograph your subject in direct nondiffused sunlight coming through a window, you have more light to work with, but the light is contrasty and your subject has a tendency to squint.

Indoor existing light, artificial or otherwise, may be quite contrasty; for example, when your subjects are close to the source of light and well-illuminated, while other areas of the scene are comparatively dark. By turning on all the lights in the room, you can make the illumination more even and provide additional light for exposure and at the same time reduce the scene contrast. The contrast created by some artificial lighting can also be reduced in an average size room by bouncing auxiliary light off the ceiling or by using reflectors. Adding auxiliary bounce lighting or reflectors means you are not making true existing light pictures, but this extra light helps to reduce contrast without spoiling the natural appearance of the scene.

Fluorescent Lighting

Indoor scenes illuminated by fluorescent lights usually appear pleasing and natural in real life; however, color pictures of these same scenes often have an overall color cast that makes them appear unnatural. Fluorescent light emits blue and green light primarily and is deficient in red light. Most color pictures made without a filter under fluorescent light are also deficient in red and have an overall greenish appearance. Used correctly, fluorescent light has some advantages over other types of available light. A room illuminated by fluorescent lamps is usually brighter and more evenly lighted than a room illuminated by tungsten lamps. This higher level of light makes it easier to get enough exposure for your existing light photography and helps record detail that may have been lost in the shadow areas with other types of existing light. When photographing people, however, fluorescent lighting often causes dark shadows under the subject's eyes. These shadows cause the eyes to appear dark and sunk in.

For making color pictures under fluorescent lighting, a negative color film with the appropriate filter is most often your best bet. Color negative film has a wide exposure latitude that permits, to some extent, a variation in exposure without detracting from the quality of the finished print. The greenish effect caused by fluorescent lighting can be partially corrected when the color negatives are printed.

For color slides with fluorescent light, a daylight type of film with the appropriate filter is best. Tungsten film usually produces slides with too much blue or green when made with fluorescent light.

As discussed in chapter 3, the use of filters for color photography helps to overcome the deficiency of red light in fluorescent lamps. Always consult the *Photo-Lab Index* for the best film filter combinations to use.

Pictures Outdoors at Night

Outdoor night scenes usually include large areas of darkness broken by smaller areas of light from buildings, signs, and streetlights. Pictures of outdoor scenes are quite easy to make because good results are obtainable over a wide range of exposures. Using short exposures emphasizes well-lit areas by preserving the highlight detail, while the shadow areas are dark because of underexposure. Long exposures help retain the detail of the dark areas, while highlight detail is lost because of overexposure.

Large, dark areas in night scenes make it difficult to make accurate exposure meter readings from your camera position. The best meter reading results are obtained when you take closeup readings of important scene areas.

Color outdoor pictures at night can be made on either daylight or tungsten-type films. Pictures made on daylight film have a warm, yellow-red appearance. Those made on tungsten film have a colder more natural look; however, both films provide pleasing results, so it is a matter of personal preference which you use.

A good time to make outdoor night color pictures is just before it gets completely dark. At this time, some rich blue (or even orange) is in the sky. This deep color at dusk gives a dramatic background to your pictures. Neon signs, streetlights, and building lights make bright subjects for your pictures. At night, right after it stops raining and everything is still wet, is another good time to make outdoor pictures. The lights in the scene produce many colorful reflections on the wet pavement, adding interest to what may otherwise be a lifeless, dull picture.

Many buildings look rather ordinary in daylight, but at night, they are often interestingly lighted. Try photographing the hangar at night, with the lights on and the hangar doors open. Also, your ship at night, especially a rainy night may make a very striking picture.

Outdoor events that take place at night in a sports stadium are usually well-lighted and make excellent subjects for existing light pictures. Most sports stadiums (as well as streets) are illuminated by mercury-vapor lamps that look blue-green in color when compared to tungsten lamps. Your best color pictures made under mercury-vapor lighting will be shot on daylight color film, although they will appear bluish green because the lights are deficient in red.

Tips for existing light photography are as follows:

- Carry a flashlight so you can see to make camera settings.
- If you do not have an exposure meter or cannot get a good reading, bracket your exposure.
- Focus carefully; depth of field is shallow at the wide apertures required for existing light photography.
- When you have a scene illuminated by a combination of light sources, use the type of color film recommended for the predominant light source.
- For pictures of fireworks, support your camera on a tripod, focus at infinity, and aim the camera toward the sky area where the display will take place. Open the shutter for several bursts.

ELECTRONIC FLASH LIGHTING

In situations where there is little or no light available, a portable electronic flash unit is an invaluable piece of photographic equipment. With fast films and long exposures, you may be able to shoot existing light pictures, providing your subject remains still long enough. Although you can certainly get better lighting control with elaborate photographic lights, the simplicity and portability of electronic flash is unbeatable.

Electronic flash provides an excellent source of artificial light for exposing black-and-white and color daylight-balanced film. Light from an electronic flash unit (strobe) is characterized by softness, short duration, and color balance, approximating that of daylight.

By measuring the amount of light that actually reaches an object or scene, you can obtain a numerical value that can be converted directly into a flash guide number. The numerical value is the light output rating of an electronic flash unit measured in beam candlepower-seconds (BCPS) or more correctly, effective candlepower-seconds (ECPS).

Every electronic flash unit is assigned a guide number as a measure of its light output or power. The higher the guide number, the greater the light output. Guide numbers for various film speeds are usually

provided with each electronic flash unit. Information packaged with film may also provide guide numbers appropriate to their speed in regard to the various powers of electronic flash units. Manufacturers tend to overrate the power of their electronic flash units. When guide numbers are assigned by the manufacturer, they base the guide number on an average reflective subject and in a room with 10-foot light-coloredceilings. By using these methods, the manufacturers are able to take advantage of the films exposure latitude.

Like exposure meters, guide numbers are not infallible and some variation from assigned values should be expected. To ensure accuracy of the flash unit, you must check the efficiency of your electronic flash unit to determine your own reliable guide numbers. The steps used to check efficiency are as follows:

1. Place your flash unit (on the camera) exactly 10 feet from a live model who is holding a series of cards-one for each f/stop marked on your lens.

2. Load the camera with the type of film you want to test.

3. Focus the camera on the model and make an exposure at each of the f/stops marked on the cards.

For each exposure, instruct the model to hold up the card marked with the f/stop to be used so it shows noticeably in the picture. Process your film normally, examine the proof sheet or slides carefully, and choose the one shot that best reproduces the model's skin tones. Multiply the f/stop on the card in that picture by 10 (the flash-to-subject distance) and you have the guide number for that particular film and flash unit combination. If, for example, the best exposure was made at f/8, the guide number is 80 (8 x 10 = 80). Once you have determined the correct guide numbers for use with various films, make up a reference chart and attach it to your flash unit.

Correct exposure with electronic flash depends upon four factors:

- The power or light output of the flash unit
- The IS0 speed of the film being used
- The flash-to-subject distance
- The f/stop setting

Shutter speed is not a factor since the time of exposure is governed solely by the duration of the flash.

Notice we always speak of *flush-to-subject distance*, never camera-to-subject distance. With all types of artificial illumination (the same as with sunlight), the only consideration is the amount of light reflected from the subject. The distance between the camera and the subject has no bearing on exposure. When the flash is used off of the camera, the basic f/stop is still calculated with the flash-to-subject distance.

AUTOMATIC ELECTRONIC FLASH UNITS

Most electronic flash units can be operated in an automatic exposure mode. An automatic flash unit eliminates the need to determine the correct f/stop for each flash-to-subject distance, providing the subject is within the flash distance range of the unit.

On the front of an automatic flash unit, a sensor reads the light reflected from the subject that is produced by the flash. When this sensor is satisfied with the amount of light received, it automatically shuts off the flash. The closer the subject is to the lamp, the quicker the sensor shuts off the light.

Some automatic electronic flash units allow you to select two or more apertures to control depth of field. To determine an f/stop in the automatic mode, you can use the calculator dial, located on the unit that is being used. By matching the indicator to an IS0 film speed number on the dial, you can use the f/stop within a minimum and maximum distance. Once an f/stop is selected and set, it becomes a constant factor regardless of the flash-to-subject distance, providing it is within the flash distance range of the unit. This feature allows the photographer to move closer to or farther away from a subject without having to calculate an f/stop for each change of flash-to-subject distance (fig. 5-25).

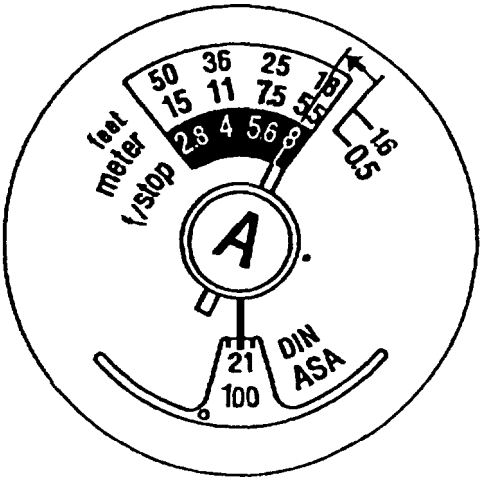


Figure 5-25.–The automatic operating range, using JSO 100 film at f/2.8, is 1.6 to 50 feet.

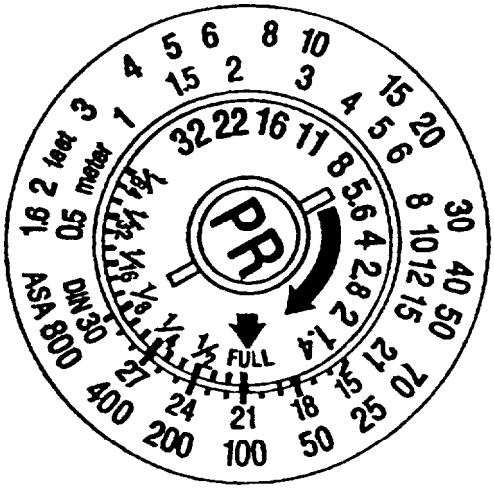


Figure 5-26.–Manual exposure scale.

When the flash unit is in the manual mode, the f/stop must be changed each time the flash-to-subject distance changes. A scale on the flash unit indicates the proper f/stop to use for the various distances. To determine the flash-to-subject distance for on-camera flash, focus on the subject and read the distance directly from the focusing ring on the camera. Figure 5-26 indicates with IS0 100 film at full power the proper aperture setting at 10 feet is between f/11 and f/16.4 feet is f/32, 40 feet is f/2.8, and so forth.

SINGLE FLASH

The majority of your indoor photographs will be produced using a single-flash unit. Numerous reenlistments, frockings, and promotion ceremonies are conducted indoors where the lighting conditions are unfavorable for available light photography. There are various methods in which a single flash can be used to produce high-quality professional photographs that distinguish you, the Photographer's Mate, from the amateur snapshooter.

On Camera Flash

A commonly used flash technique is to have the flash unit attached to the camera in synchronization with the shutter and aimed directly at a subject. An advantage of having your flash unit attached to the camera is it provides you the chance to capture the unexpected-the truly candid shot. When spontaneity sparks the action and quick-camera handling is a must, the fewer pieces of equipment you have to worry about or handle the better. Rather than two pieces of gear-the camera and the flash-you have only one-the camera with the flash attached to it; however, this technique usually produces objectionable shadows behind the subject.

To help reduce the harshness of the shadows produced behind your subject when a single flash is used at the camera, place some diffusion material, such as a white handkerchief, cheesecloth, or frosted cellulose acetate, in front of the flash. Of course, diffusion reduces the intensity of the light, and the exposure has to be increased accordingly when using the manual mode on the flash unit.

Most imaging facilities are equipped with flash brackets. When you are using a flash bracket, it is possible to rotate the flash when changing formats from horizontal to vertical. When shooting people in the vertical format using a flash unit, always position the flash above the lens. If the flash is below the lens, long objectional shadows are cast behind the subject, and the subject has an unnatural, eerie, sinister effect.

Red Eye

A result that may appear with direct flash is "red eye." Red eye occurs in pictures of people and animals when the flash is used close to the optical axis of the lens and the subject is looking at the camera. Light reflecting from the blood vessels at the back of the eye causes this effect. The darker the room is, the stronger the effect, because the pupils of the eyes become more dilated. Red eye can easily be avoided by moving the flash away from the lens optical axis. Also, the effects of red eye can be minimized by turning up the room lights.

Bounce Flash

One of the better methods to illuminate a subject or scene with a single-flash unit is to use *bounce flash.* There are times when you want a very soft light in order to lessen the tonal range between highlights and shadows and to soften harsh background shadows. You can achieve this soft lighting by bouncing, or reflecting, the flash off a light-colored surface. By doing so, you are changing the narrow spot of light from a flash unit into a wide diffused area of light. When shooting color film, avoid colored walls and ceilings. They reflect their color onto the subject, causing a color cast over the entire subject area. You should use bounce flash in all

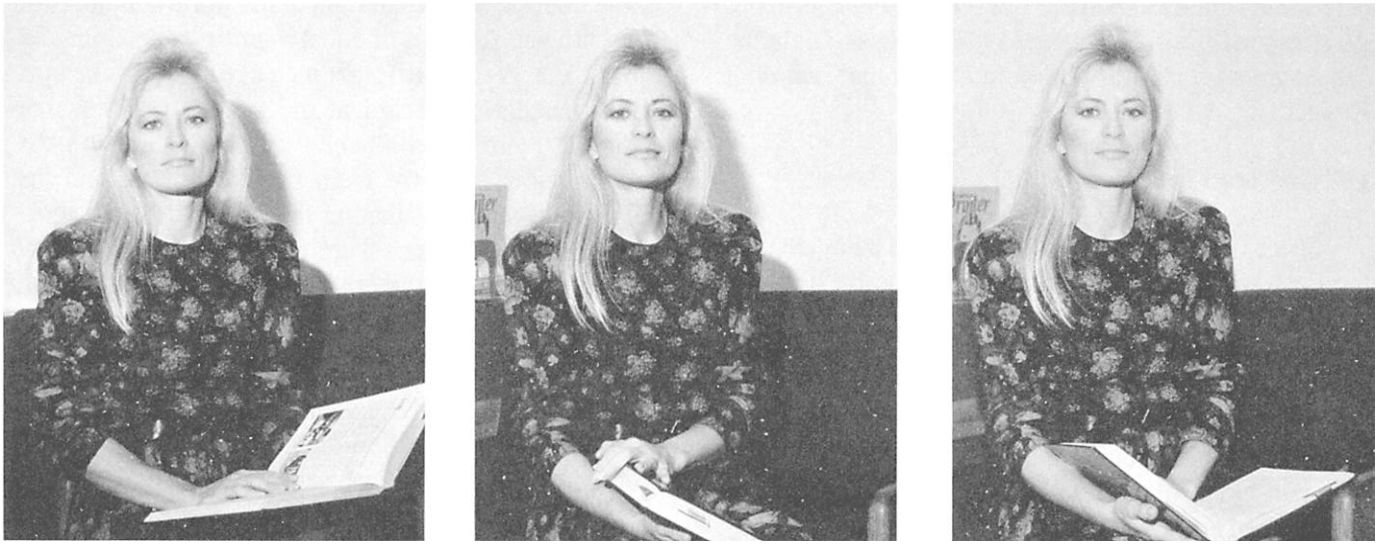


Figure 5-27.–Effects of direct, diffused and bounce flash.

situations where there is a 8- to 10-foot-white ceiling. Your photographs of reenlistments, frockings, awards, and so forth, will have a more pleasing effect.

Most bounce flash pictures are made with the light directed at the ceiling, either above the photographer or above the subject, or somewhere between. A silhouette effect can be produced by bouncing your flash off the ceiling behind the subject. To accomplish this, aim your flash unit so most of the light bounced off the ceiling falls on the background behind the subject and calculate the exposure for the background.

For the flattest bounce light, try bouncing the light off a wall behind the camera. With this lighting, you will have practically no shadows. Here, you have to calculate your exposure based on the flash-to-wall-to-subject distance.

For side lighting, bounce your flash off a wall to the side of your subject. This type of lighting helps add a feeling of three dimensions to your picture.

For the best control, use a large reflector designed for bounce lighting. Special-made reflectors are available that are lightweight, compact, and portable. For closeup work, the best bounce reflector is about 3 by 4 feet square. For full-length subjects, try a reflector about 6 by 6 feet.

To determine the exposure for bounce flash using the manual mode on your flash, you must determine the flash-to-ceiling-to-subject distance and determine your f/stop and then open the aperture two additional f/stops. The two additional f/stops are added to compensate for loss of light due to scattering and absorption by the reflecting surface.

When an automatic flash is used in the automatic mode, it is not necessary to open up two f/stops. The sensor automatically cuts off when the proper amount of light is reflected from the subject to the flash unit.

When the ceiling is high or dark, a compensation to the basic exposure may be required. For effective use of the bounce-flash technique, a considerable amount of practice is required. As with any flash photography technique, identify any areas or surfaces that may be potential problems. Remember, one of the basic principles of reflected light is that the angle of incidence is equal to the angle of reflectance. Highly polished or glass surfaces should be considered before the subject is photographed. Items, such as windows, glass tabletops, glass framed photographs and polished metal, can cause glare or a “hot spot” in your photograph. When you are using bounce lighting techniques, “hot spots” of vertical surfaces are normally prevented, because the light source striking the surface is angled from above or the side; however, when you are using bounce lighting techniques, horizontal surfaces, such as glass coffee tables and overhead light fixtures, can cause a strange diffused lighting pattern in the photograph.

When using a single, on-camera flash, experiment with direct, diffused, and bounce-flash techniques and

determine which method provides the best results under various conditions. The method you choose to light the same subject separates you from the average snapshot shooter (fig. 5-27).

Off Camera Flash

Some of your best flash pictures can be made with the flash unit off the camera. Holding the flash off the camera and above the lens tends to throw the shadows down and behind the subject. This is a good way to minimize distracting background shadows that occur when a subject is standing close to a wall. A flash held high above the lens, either left or right, makes the viewer less conscious of the flash illumination. People are accustomed to seeing things lit from above, and by placing the flash above the subject, it closely resembles the lighting of the sun or ceiling lights.

Light that is far enough off the camera to illuminate the subject from an angle produces modeling or roundness. This type of light creates the illusion of a third dimension-depth-and is more pleasing to the viewer than the two-dimensional flat effect you get with direct, front lighting. Light from an angle can also be used to bring out the texture of a subject.

Indoors, two factors are important when determining the modeling and texture effects you will get: first, the surface of the subject itself; second, the way you light that subject. To illustrate these points, try photographing a Ping-Pong ball and a tennis ball together. When you use direct, front lighting, your picture records a two-dimensional visualization of height and width, but little of roundness, depth, or texture. When you light the balls from the side, both acquire the illusion of depth; however, only the tennis ball reveals texture. The Ping-Pong ball is much smoother and is almost textureless.

Now substitute a young child and an old person for the balls. With frontlighting, most of the lines and wrinkles in the old person's face will be minimized by the evenness of the light; however, when lighted from the side, almost every crease will become a shaded area and the ridges will be highlighted. Thus the texture of the old person's face is emphasized. The child, on the other hand, when side lighted, is still almost textureless just as in the case of the Ping-Pong ball.

LIGHTING RATIO

Lighting ratio can be considered as a measure of contrast. Lighting ratio refers to the combined intensity (at the subject) of the main and fill lights as compared to the intensity of the fill light alone; for example, both the main and fill light of equal intensity are shining on the subject. A reflected light meter reading is taken off an 18-percent gray card at the subject position that indicates there are 100 units of light falling on the subject. Now, with the main light turned off and the fill-in light still illuminating the subject, the reflected meter reading indicates there are only 50 units of light falling on the subject; therefore the lighting ratio is 2 to 1. Lighting ratio is usually expressed as the comparison of two light intensities, such as 1:1, 2:1,3:1, and so on.

The largest number in a lighting ratio indicates the most intense illumination at the subject position; for example, a 2:1 ratio indicates the most intensely lighted portion of the subject (highlights) is receiving twice the amount of illumination as the least intensely lighted portion of the subject (shadows). The light that produces the most intense illumination is called the main, key, or *modeling* light. The light that produces the least intense illumination is called the fill, or fill-in. A fill or fill-in light, as the name implies, fills in and softens the shadows produced by the main light.

Because a lighting ratio is a comparison of the combined main and "fill light" illumination intensities to the fill light illumination intensity alone, the fill light must be in a position so it completely illuminates the portion of the subject visible to the camera. This requires positioning the fill light close to the lens.

As a rule, 3:1 lighting is considered the best general lighting ratio for both black-and-white and color photography. This 3:1 ratio provides normal contrast between the highlights and shadows and produces good natural-looking photographs.

Some automatic electronic flashes allow you to control the output of light. When set in the manual position, you can adjust the light output by changing the intensity of the flash unit to 1/2, 1/4, 1/8, 1/16, and so forth. This allows you more control of flash-to-subject distance as well as aperture (depth of field) control.

Achieving the desired lighting ratio with an automatic flash unit where the flash intensity can be controlled is quite easy. To achieve a 2:1 ratio, you set both flash units at the same distance and at the same intensity (either full power, 1/2, 1/4, and so on). To achieve a 3:1 ratio, set both flash units at the same distance and set the main light flash at full power and the fill flash at one-half power. A 5:1 or even higher lighting ratio can be obtained by setting both flash units at the same distance and the main flash at full power and the fill flash at one-fourth power, and so on. In order to

select a wider aperture to control depth of field, start by setting your main flash at one-half or one-fourth power and adjust your fill flash appropriately.

Adjusting lighting ratios by flash-to-subject-distance is another method to control lighting ratios. An easy way to calculate footage for a 3:1 ratio with two lights of equal intensity is to think of the full f/stops (2, 2.8, 4, 5.6, 8, 11, 16, 22, etc.) as distances in feet. Place the main light at the desired distance closest to one of the "f/stops," and place the fill light at the distance indicated by the next larger number; that is, 5.6 feet and 8 feet or 16 feet and 22 feet, and so on.

Another easy method to control the lighting ratios using an automatic electronic flash is to use the flash unit in the automatic mode. When set in the automatic mode, the flash-to-subject distance is not supercritical, and there is some leeway as long as the flash units are within their operating range.

To obtain a 2:1 lighting ratio, you simply have both flash units set at the same automatic setting and at approximately the same distance from the subject. For a 3:1 lighting ratio, use the same automatic setting and approximately the same flash-to-subject distances, but set the fill flash at twice the film speed as the film being used (main flash setting). For a 5:1 or even higher lighting ratio, use the same automatic setting and approximately the same flash-to-subject distance and set the fill flash at four times more than that of the main flash, and so on.

Any lighting ratio can be obtained when using an automatic flash unit. By controlling the power output intensity, adjusting the film speed setting, changing the main and fill flash distances, or a combination of the three, you can manipulate the lighting ratio easily to any ratio. As with any stage of photography, practice and testing with your camera and flash combinations in various situations produces the best results.

SYNCHRO-SUNLIGHT

Bright sunlight, used as the only means of illumination for an exposure, can produce deep objectional shadows on a subject. When a flash unit is used as a fill-in source of illumination, it reduces these shadows and is known as synchro-sunlight photography.

Improperly handled, the synchro-sunlight technique can produce an effect that makes the photograph appear as if taken at night with a single flash. This effect occurs when the flash illumination is more intense than the sunlight.

The first step for proper exposure with synchro-sunlight is to calculate the correct exposure for daylight, and set the shutter speed and f/stop as though a flash is not being used; however, keep in mind when using a focal-plane shutter, the shutter speed must be synchronized with the electronic flash unit. Avoid using a fast film in bright sunlight when using a camera equipped with a focal-plane shutter. In this case, you are limited only to your aperture to control the exposure of the film, because your shutter speed is nonadjustable. A leaf shutter has an advantage over a focal-plane shutter. When a leaf shutter is used, it provides more control over depth of field since the shutter synchronizes at all shutter speeds.

When you are using an automatic flash, the same principles apply for synchro-sun that were explained in the section for lighting ratio. The sun is used as the main light, and your camera settings are determined directly from your light meter. The easiest method is to set the film speed (ISO) on your flash unit to twice the film speed being used for a 3:1 lighting ratio and four times the film speed being used for a 5:1 ratio. A fraction of the manual power output can also be used to achieve the desired lighting ratio.

Remember to compensate your exposure by opening up two f/stops for a backlit subject and one f/stop for a subject that is sidelighted when taking your light meter reading from a distance. For color photography, you should normally use a 2:1 or 3:1 lighting ratio. For black-and-white photography, a ratio of 3:1 to 5:1 is acceptable.

MULTIPLE-FLASH UNITS

Multiple flash is the use of two or more flash units fired in synchronization with the camera shutter. The flash units can be auxiliary flash units, connected to the camera by extension cords, or they can be slave flash units. Slave units usually have self-contained power sources and are fired with a photoelectric cell when light from a master flash unit strikes the cell of the slave unit.

With multiple flash, exposure calculations are based on the distance between the subject and the flash unit that produces the most intense illumination to the subject; therefore, you can have numerous auxiliary flash units or slaves for a scene and only calculate your exposure from the mainlight source. All other flash units should be equidistant or at a greater distance from the subject as compared to the flash unit on which the exposure is based.

When two flash units of equal intensity and at equal distance from a subject illuminate the same area, the exposure for one unit should be determined and then the exposure should be halved because twice the intensity of light is reflected from the subject.

OPEN FLASH

Flash pictures can be made without the camera shutter and flash being synchronized, using a technique called open flash. In the open-flash method, the camera shutter is set at T or B, the shutter is opened, the flash unit fired, and the shutter closed. The open-flash technique is sometimes used when the level of light over a large scene is very low or at night. This method of flash photography allows the photographing of large scenes that ordinarily are quite difficult to illuminate with artificial light. The photographer can walk into a scene with the flash unit and illuminate sections of the scene or the entire scene. Any number of flashes can be used during the exposure while the shutter remains open. A silhouette of your body can be recorded if your body gets between the flash and the camera.

To arrive at the exposure for an open-flash picture using a manual flash, determine your flash-to-subject distance and f/stop. Keep the distance equal to the objects being illuminated when using manual flash; for example, when the f/stop for the scene is f/5.6 based on a flash-to-subject distance of 10-feet, every flash within the scene should be 10 feet from that section of the scene being illuminated, When an automatic flash is used, the flash automatically shuts off when the proper amount of light is reflected from the subject, providing the object is within its distance range. When you are using a manual flash, the exposure for open flash is determined as previously discussed. This is true unless two or more flash units with equal intensities are used at equal distances, or two or more flashes from the same unit at the same distance are used to illuminate the subject.

MULTIPLE EXPOSURES WITH ELECTRONIC FLASH

Interesting multiple exposures can be made with only one or two electronic flash units. Multiple exposure pictures, besides being artistic and interesting, are often used to study subject motion and position. This can be accomplished by the following procedures:

1. Darken the room and position your subject against a black background.

2. Allow enough background area for the number of different exposures you intend to make. When you are using a ground glass camera, mark off on the glass, with grease pencil, the areas where the subject should be for each different exposure. If not using a ground glass camera, make a pencil sketch to help you position the subject.

3. Set up the electronic flash lights so the minimum amount of illumination falls on the background itself.

4. Turn off all room lights and make your first exposure. Then, without advancing the film, move your subject to the next position for the second exposure. Repeat this procedure for each image you want to record on the film.

PHOTOGRAPHING ACTION WITH ELECTRONIC FLASH

Action of any kind, no matter how slight, can add interest to most pictures. Each type of action requires a different camera technique, but because of the short duration of light from electronic flash, it is ideal for recording any action ranging from a fleeting expression to a sports triumph. Most electronic flash units have a maximum flash duration (the length of time the light is on) of about 1/800th second, and a minimum flash duration as short as 1/20000th second, thus you can "freeze" almost any action with the flash.

Indoors, where there is little existing light, you have no problem because the electronic flash itself stops the action; however, outdoors in daylight, you may encounter ghost images. Ghost images can occur when existing light and a slow shutter speed are used in conjunction with electronic flash. A ghost image appears as a blur when one image is recorded by the existing light and a second sharp image by the electronic flash.

ELECTRONIC FLASH AT NIGHT

Flash photography, outdoors at night, can produce very underexposed photographs if not taken properly. Outdoors, flash does not carry very far; therefore, it can be difficult to light objects from a distance; however, this limited coverage also gives you great control. Indoors, part of the output of a flash unit is reflected from the ceiling and walls back to the subject. Rarely do you find such reflective surfaces outside, so some light is lost. To compensate for the light lost, you must open up your aperture when photographing objects at any distance. Because so much light is absorbed in these large areas, it may not be uncommon to open up your aperture two or three f/stops. Tests should be conducted before shooting in large, indoor areas, such as gymnasiums and hangar bays or outdoors at night, to

determine which flash, camera, and film combination produces optimum results.

At night a single on-camera flash produces stark lighting, and your subject is flatly lit and the background goes completely black. Close foreground details become very overexposed, and it is better to exclude them. Such simple lighting is ideal for action shots; for example, capturing leaping karate experts in midair at midnight. Subjects such as these benefit by being isolated from the background, but you may get more interesting lighting by using the unit off camera on an extension cord.

If the necessary flash-to-camera distance is greater than the length of your extension cord, use the open-flash method. Do not allow the camera to "see" the flash unit during the open-flash exposures.

Now that you have a basic knowledge of photo graphic techniques, it is important that you apply and practice the basic principles. Each and every time you pick up a magazine, book, or newspaper or watch TV or see a movie, you are exposed to various composition and lighting techniques. Study them and apply them every time you look through the viewfinder of a camera Remember, experiment with different camera angles to create interesting perspectives of your center of interest. Whether using available light or flash photography, notice what results the direction, intensity, and type of light have on your final product. Continual application and refinement of the principles of composition and lighting can greatly enhance the quality and aesthetic value of your photography.

CHAPTER 6

PHOTOGRAPHIC ASSIGNMENTS

Photography in the Navy has long been an important tool for monitoring the strength and improving the methods of our nation's fighting forces, as well as serving to record for historical permanence the significant events that have shaped our nation's destiny. From the moment that Matthew Brady exposed his photographic plates on the decks of the federal ironclad ship, *Monitor*, in 1862, the Navy has used photography as a significant recording medium. It has influenced the development of weapons and ships in the Navy and has been an invaluable aid in training the men and women who make up today's Navy.

Today we can go to the archives and look back with pride at the visual evidence of the Navy's growth, generation after generation. The historical record tells us where we have been, what we were, how far we have progressed, and how we have changed-enhancing our perspective of the past and clarifying our perception of the future.

The "grandfather" of our profession, still photography, is the oldest of photographic skills in the Navy. Where events of historical significance occur, such as military exercises, ships being commissioned and decommissioned, and newsworthy events of interest to Navy personnel, there are Navy photographers recording events as they happen.

PLANNING

Planning prevents disappointment. If only I had an idea of what to expect, this picture might have been better. How many times have you said this to yourself? Planning does not cover all the bases on every assignment, but it can be valuable on many of them.

Color or black and white . . . small, medium, or large format? This question may sound basic, but you should consider it thoroughly when preparing for an assignment. Take time to consider the finished product and its intended use.

Punctuality is the only policy. As a minimum, be on time. However, why not get there 10 or 15 minutes ahead of the assigned time? You can use this time to look over the area for lighting, background, props, and so forth. Also, discuss the assignment and what you need with the people connected with them. Take charge courteously. Politely ignore harassers. Begin work at once and give clear, concise directions. But do not think this approach takes the place of your responsibility to BE COURTEOUS AT ALL TIMES.

Dependability versus creativity. Strive to shoot for the results that your customer requested. Then shoot what you consider to be an improvement on the original requirement.

Pictorial details are important. Before the shutter catches that moment, make sure you have checked or considered the foreground, background, arrangement, expressions, clothing, angle, and lighting. You have to mentally put all these items together and say to yourself, Will this tell the story?

Identify. When the photograph has been recorded, begin taking identification Caption information should include name, grade, and title. If possible, you might have someone on the scene taking identification while you are shooting.

Always check your equipment before leaving for a shooting assignment. As a minimum, you should take several extra rolls of film and a spare synchronization (sync) cord. When using a flash and a large number of photographs are to be taken, you may need an extra battery pack. Always be prepared and attempt to overcome the unexpected.

EQUIPMENT

After learning the nature of your photographic assignment and making a complete analysis of the assignment, you must choose the proper equipment to get the job done. The variety of photographic equipment available and suited for location assignments is extremely broad; for example, the assignment may require the use of a 35mm, medium format, or even a 4x5 view camera The lighting equipment you choose may range from a small, compact electronic flash unit to a complex array of lighting equipment and reflectors. Exposure meters, color temperature meters, tripods, and interchangeable lenses are just a few of the other accessories you may need on a location assignment.

"Be prepared." At one time or another we have all heard that familiar quotation. But have you ever thought what this could mean to your assignment? For want of

a gizmo, a photograph was lost; for want of a photograph, an assignment was ruined; and for want of an assignment, your reputation as a photographer was destroyed. No, we are not really concerned with gizmos here. What we are concerned with is your equipment. Do you have everything you need when you get to your assignment and does it work? Nearly all photographic equipment has one or more critical components-the failure or loss of which may put a vital piece of gear out of operation. With cameras, one of these items is the battery, because it may power both the meter and the shutter. Check the battery before you leave the lab, and ALWAYS carry a spare. You have a super deluxe all-powerful electronic flash unit that can light up the entire hangar deck in the wink of an eye. Or can it? Did you check it out and was it working before you left the work center? Did you remember the power cord and an extra sync cord? Speaking of synchronization, did your make sure the flash was in sync with the camera shutter? Or was the shutter even working? What about the camera lens-is it clean, does it focus correctly? The diaphragm-is it working?

In the studio, a minor failure usually only causes embarrassment and gives the impression of un-professionalism. You can usually get a spare camera, lights, and tripod into service. But when you are out on location, you are limited in what you can take with you; therefore, it is important that ALL your equipment be thoroughly tested and operating correctly BEFORE you leave the work center.

MARKING YOUR EQUIPMENT

If you have been issued your "own" equipment, put your name on it. Of course, you should not put your name on it permanently. Use stick-on labels. Having your name on your equipment does not keep anyone from stealing it; it is only there to let other people in the workcenter know it is "yours" **and they best keep their hands off.** Navy photo equipment must be marked permanently with both a serial number and "U.S. Navy Property." If the manufacturer did not include a serial number on the equipment, a local serial number is assigned, using the unit identification code (UIC) under which the equipment is assigned, plus a dash and a two or three-digit number that identifies the specific piece of equipment; for example, if you receive a new light meter without a manufacturer's serial number, your work center UIC is 62093, and you have 76 other pieces of equipment assigned local serial numbers, then the serial number for the new meter is 62093-077.

EQUIPMENT SECURITY

In the photo lab, your equipment should be secured when not in use. Most imaging facilities have a camera-crew ready room or locker that is kept locked so only authorized personnel have access to valuable photo equipment. On location, however, security is another matter, particularly when away from your home station. There may be times when you must leave equipment in a BEQ or motel room. There are measures you can take to protect this equipment. The first principle is do not advertise your equipment. Do not put anything on the equipment cases to indicate they contain photographic equipment. Do, however, put your command address on the cases. The second principle is not to leave photo gear out of your sight any longer than necessary. Carrying a camera bag with you to chow may be inconvenient-but this is better than leaving it unattended somewhere. Also, do not leave your photo gear in a location where it could easily be picked up or stolen. Keep a strap attached to the bag or case, and drape it over your knee.

PHOTOGRAPHING PEOPLE

People are probably one of the most rewarding subjects for photography. Good pictures of people capture the gestures and expressions that convey vitality and character without the subject appearing self-conscious.

Basically, assignments for photographing people fall into two general categories: pictures of a single person and pictures of a group of people.

For the mediocre photographer, all the picture of a person must do is identify a person. But good photographers steer away from these identification pictures. The photographer is after something different, something not too loose and not too formal-something that pictures the person, not just his features. One approach to capture these characteristics is the candid photograph.

CANDID PHOTOGRAPHY

Most photographers are familiar with candid shots of people they do not know. It may be true that the average photographer thinks of a candid photograph as one that is not set up or one the subject does not know is being taken. Photographers have learned that candid techniques can be used just as effectively to make pictures of people they know, even when the people know they are being photographed. The key to success as a candid photographer is to keep a low profile, but you do not have to be sneaky. A candid shot is a candid shot, whether it is of the admiral at a news conference

or a “genuine candid” of a sailor you just happen to see. The technique is the same in both cases. All that is important is for the pictures not to appear posed. The subjects of candid photographs are not posing or acting; they are simply being themselves and behaving as though the photographer is not there.

The compactness of 35mm cameras make them ideal for candid photography. SLRs with their fast, interchangeable lenses, TTL metering, and large film capacities make candid photography one of the most rewarding areas of our profession. A long-focal-length lens is also a good choice for this type of photography. The long lens lets you maintain distance between yourself and the subject, and, if people are aware of your presence, they will not be as self-conscious. If you are taking “real” candid shots, a long lens is a necessity.

When people know you are shooting them, get them to occupy themselves, so they will “forget” there is a camera watching them. Only then, can you get a truly candid picture. When the person notices what you are doing, ask their permission before you shoot. People usually will not object, particularly if you are polite and work quickly. Stay casual and relaxed. People soon get used to seeing you with the camera, and you will be on your way to some good candid pictures.

Preset your focus and exposure whenever possible so you can respond quickly and avoid attracting attention to the camera. Estimate the likely subject distance, set it on the lens focus scale, and stop down for greater depth of field. Camera handling must be fast and smooth. Time does not allow for fumbling with camera controls, flash equipment, exposure meters, and film loading.

Keep alert, keep looking, and keep shooting. Shoot plenty of film. Do not be stingy; in the long run, film is cheap. You will miss enough good pictures by the very nature of your subjects-people-and being tight-fisted with film does not increase your chances for getting good pictures.

Do not try to control the people you are shooting. Let them assume a natural “pose” in an appropriate setting. You may tell them, “please do not look at the camera.” Try to capture the details of their environment in your pictures. This adds interest to what they are doing. And finally, make your candid pictures reflect the people and events around you.

There are situations when you do not have the time for a candid approach, or it just is not feasible. You can still produce interesting people pictures by using the "frame approach."

FRAMING PEOPLE IN THEIR ENVIRONMENT

The "frame approach" simply means posing your subject in a situation or environment that is most meaningful to the subject or assignment.

When your subject is a chaplain, place him before a chapel or at a desk with a cross that is visible over his shoulder. If the person is a Boatswain Mate, get him or her on deck actually working on the job. Put the Navy instructor near a blackboard or the pilot in an aircraft. The frame approach works with people working in all types of environments and ratings, such as Machinist's Mates, Airman, Fireman, Personnelman, Opticalman, and so forth. It works with just about everybody. It is easy. Your subject is usually more relaxed in his or her own environment, and props to work with are already there.

Before you approach an assignment, have the one key ingredient to success in mind-**a definite idea of what you want.** In other words, plan ahead. Find out all you can beforehand about the subject and the environment. What could be worse than arriving at an assignment and finding your "just average" Personnel-man is really six-foot-four, completely bald, and wearing thick bifocals. It might help to know that even though you find the person in a “closet” called an office, most of the work is done in the computer room down the hall-the one with the banks of computers and tape racks that make wonderful “frames.”

There are some things you must remember. Use the frame approach to maximum advantage. The first and foremost is to **exaggerate.** Be sure to really have a frame for your subject. If your subject is a legal officer, make sure there is no mistaking that this person works in the courts or with books and papers. If your chemist is at a blackboard, make sure that there is something on it and that the test tubes are not hidden or too few. Again, **exaggerate.** You are going from three dimensions to two. Do not be subtle. Your objective is to make a meaningful picture of a person, not just an identification shot. Vary your setup-get in tighter-back off some-change camera angles-and keep the subject prominent.

The overall result of your efforts should be a unique picture. Even if you were unable to capture the personality of your subject, the picture should at least be personable. This can be done by making the person a prominent part of the picture. Photograph the person in a meaningful environment, one that gives a sense of who the subject is, and what he does, rather than leaving the viewer with a sense of only what he looks like.

The objects needed to frame your subject must be associated with the person. You would not want to frame a Seabee with the wings of an airplane (unless of course a runway is being constructed). The Seabee would be better framed by the arch of a new building being constructed, or the hood and engine of a dump truck. The frame should add emphasis and lead the viewer to the subject. **Do not make the frame the subject.** The frame does not always have to be in focus or "box" the subject. Study pictures of people that have been framed Sometimes the frame is only on one side of the subject, sometimes in back of the subject, and sometimes only in the foreground. Seldom does the frame completely box the subject.

PEOPLE WORKING

When you read an article about someone, it may be accompanied by a picture of the person who is often at work A picture of someone at work says more to a viewer than an ordinary head-and-shoulders identification ever can, because it immediately places the person in a particular setting.

The secret to making good working pictures is to capture the atmosphere of the **place** and show the **subject** actually **working.** The use of a wide-angle lens lets you show a large work area from close in. This conveys a better idea of the working conditions. Try to bring out the atmosphere of the worker and the workplace; for example, if your subject does hard manual labor, try a low camera angle to create an impression of power. Although it is usually better to photograph a worker as though he were unaware of your presence, this is not always possible. Warn people when you are going to use the flash, so you do not startle them. When shooting at a slow shutter speed, you can even ask the worker to hold a pose.

Most people who are working are involved with something that can provide a prop: books, scale models, equipment, and so forth. Use these props to create a stage and put the people into it-really into it.

TWO-SHOTS

So far, the discussion has been based on shooting pictures of only one person. Another assignment facing the photographer is handling the two-shot, a picture showing two people.

People can be pretty awkward when told to "just be natural" or "just talk to each other." It is better to give them something to talk about. Have them talk about what they are doing. Tell them you are listening to what they say so you can have information with which to write your captions. Better yet, give them something they can actually handle, talk about, and concentrate on. This makes the situation more realistic to them, and it results in better quality pictures.

Try the frame approach for your two-shots. It is very effective. Even people can be used to frame other people.

DIRECTING PEOPLE

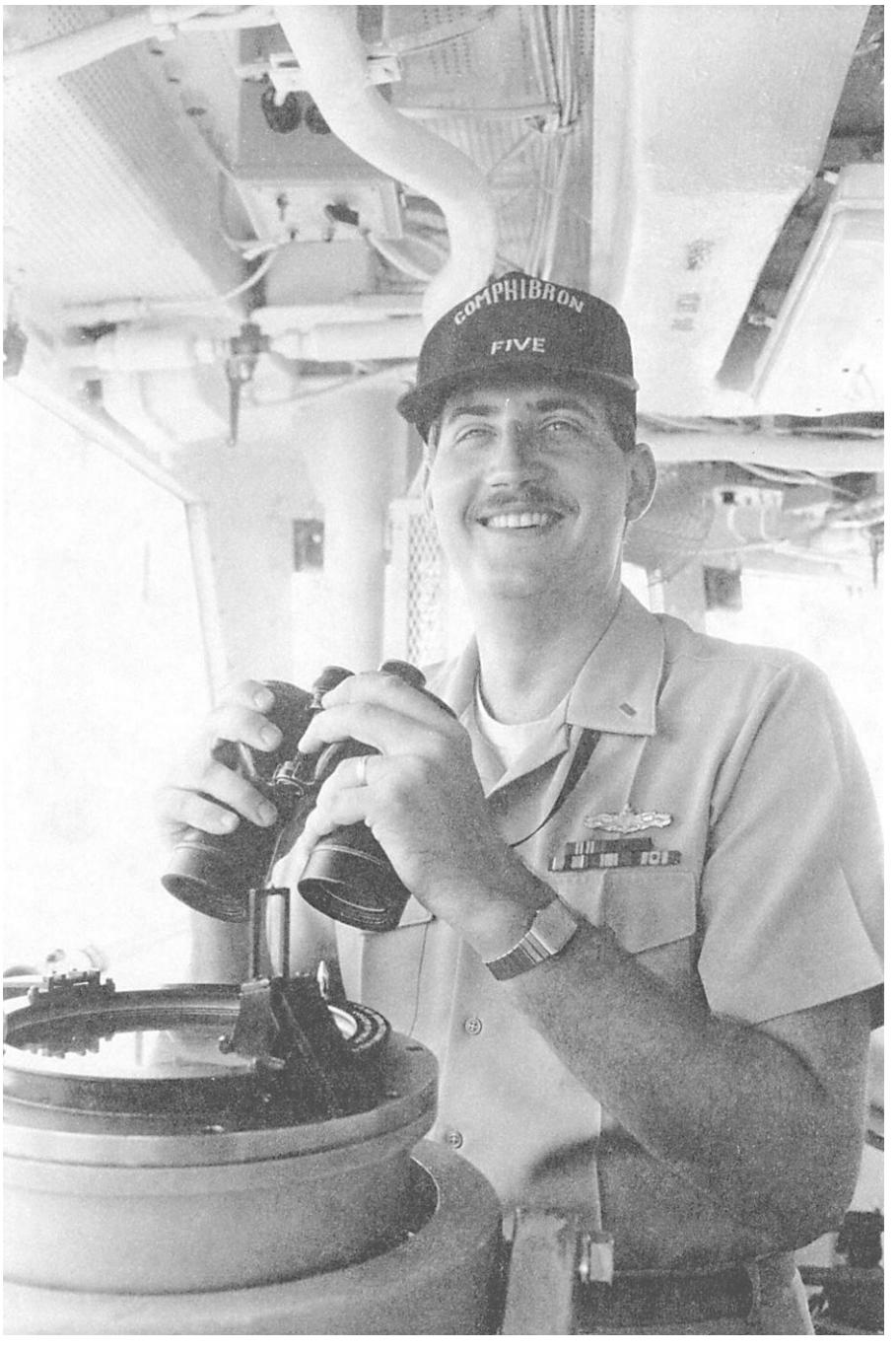
One of the most difficult tasks in photographing people is directing them. But you, the photographer, are the only one that can actually see what the picture is going to look like before it is taken. So, you must take the responsibility for setting up the "pose." It is not enough to let your subjects just arrange themselves. They have no idea what they look like.

One way to make directing and posing easier is to give your subject something to do. Do not tell your subject to "just stand there," as though in a vacuum, with nothing to do. Instead, give your subject something to handle. For a man, it might be a pipe, a book, a spyglass, or a tool they use in their work. For a child, it could be a doll, a model plane, or something of a similar nature. Often a woman can use an item of clothing in this way-a hat or a scarf.

Another useful tip is to give your subject a "prop" or a support in a more literal sense-something to lean on or sit on. A chair, stool, post, or tree can be used. When using props, frames, and poses, do not forget one important point: The Navy uses photographers so its pictures are made by professionals. These are people who know what they are photographing and the reason why. A civilian photographer could most probably make an excellent picture of a Navy scene; however, it probably will show technical errors that make the picture look like a joke to other sailors. Do a little research. If using props that you do not understand, ask about them. Do not have a sailor hauling on a line that should be taken to a capstan or a Gunner's Mate holding a 3-inch shell in front of a 5-inch gun.

Eyes are very important when photographing people. You must direct the subject to ensure that all parts of the scene are in the right place or in proper perspective. You must also direct the expression of the subject. The eyes are a very vital part of this and have a significant effect on the viewer's response. In a picture where the eyes of the subject are looking straight into the camera, a strong and immediate impact is created. This attracts viewer interest. When the eyes are directed away from the camera, the effect is less explicit and has a more ambiguous quality.

Finally, you must be in charge of the situation. It is up to you to tell the subjects where to stand, what to do, how to do it, and when to do it. This applies to everyone.



PHC Chet King
302.272

Figure 6-1A.–LT(jg) Robin T. Russler stands watch on the flag bridge of the USS *Tripoli.*

Do not fear the brass. They need directing too; after all, you are the professional and that is why they "hired" you-to do your job and to produce the best possible pictures of them. Many people are nervous and self-conscious in front of a camera. They try to look their best, and in so doing often present an expression or pose that is unnatural and displeasing. You are obligated to provide directions to the subjects regarding their pose. As the photographer, it is your responsibility to ensure that coat sleeves are pulled down, wrinkles smoothed out, hat set at the proper angle, body erect, head tilted at the best angle, and a dozen other things which, if not corrected, detract from the picture. Whether the subject is a seaman or an admiral, the photographer must observe these discrepancies and correct them. Figure 6-1A and figure 6-1B present examples of pictures of people in their environment.



JO1 Joe Lancaster
302.273

Figure 6-1B.–A member of the Army's 7th Infantry Division takes a break during the combined South Korean and U.S. exercise *Team Spirit 1990.*

One of the greatest contributing factors to poor pictures is the timid manner in which a novice photographer handles the subject. Never take a picture when something is wrong because you are afraid to speak and act in the presence of high-ranking personnel. The results will surely be disappointing and embarrassing; however, you should always be courteous and respectful in dealing with your subjects regardless of rank or rate.

GROUP PICTURES

Occasionally, assignments are received to take a picture of a group of people. There is added difficulty when working with a number of people at one time. Each person should be treated as an individual, and, at the same time, each persons relationship to the whole group must be considered. Attention must be paid to every member of the group. Every precaution should be taken



PH3 Borbely
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Figure 6-2.–Boat crews aboard the USS *Theodore Roosevelt* pose with their motor launches.

to ensure that each person is shown clearly and that interest is not drawn to one individual by some awkward pose or expression.

There are two general types of group pictures: formal and informal.

The formal group picture is one in which several people, uniformly dressed for the occasion, are seated or standing in as nearly the same pose as possible. Each member is placed in approximately the same relative position so that attention is not drawn to one person.

The informal group picture (fig. 6-2) is intended to depict an action or tell a story about the individuals concerned. Although the position and pose of each member of an informal group is carefully planned, the

results must appear casual and realistic. The members may be seated, kneeling, or standing in a variety of positions and do not have to be looking in the same direction.

Arrangement of personnel to obtain the best composition is one of the most important factors in group photography. Regardless of the number of persons in a group, they should be arranged to fill the picture in such a way so you get the largest possible image size of each person. One exception to this general rule is when the importance of the background is equal to or greater than the group itself. This often occurs with an informal group when the picture is actually intended to emphasize an object or piece of equipment, rather than the individuals. In this case, locate the camera for the best composition of the object; then arrange the people in the picture to enhance the story being told

A formal group of about five people can be composed to fill the picture area very nicely. When six to ten persons are being photographed in a group, it is advisable to arrange them in two rows. For larger formal groups, arrange the people in as many rows as necessary to fill the frame. Avoid stringing out one long, narrow line of people across the frame.

When a large group is formed into three or more rows, you must devise some method to prevent the rear rows from being blocked from view. Furthermore, in order to compose the picture properly and fill it from top to bottom, you must see that each row is higher than the preceding one. One method is to arrange the group on the steps of a building, bleachers, or a terrace, so each row is higher than the preceding one. On level ground the first row can be seated, the second standing, and the third standing on benches. Another method that can be used in combination with the first is to elevate the camera so it is pointing down at an angle on the group. This method is useful as an aid in composing and filling the picture area. A higher camera angle can be useful in eliminating an undesirable background. When raising the camera above eye level, you must avoid excessive distortion of the figures and vertical lines by too much elevation.

Particularly in formal group photography, the arrangement should be symmetrical. But avoid having an equal number of persons in each tow. Keeping the number unequal permits each person in the second and succeeding rows to stand directly behind the space between the heads in the preceding row. This provides a much better view of each person. The number in each row should differ by one person.

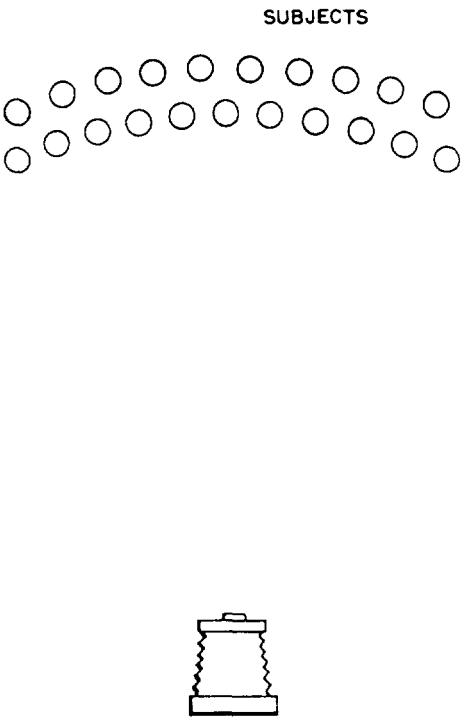


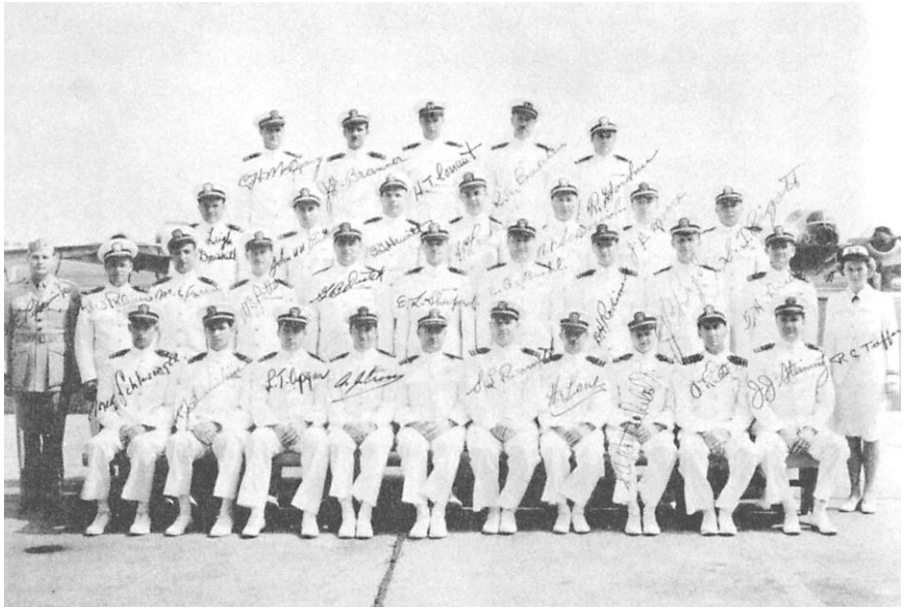
Figure 6-3.–Arrange long rows in a semicircle.

Customarily, in a formal group, the highest ranking person is located in the center of the first row and other members of the group are arranged alternately to the right and left by grade. When all members of the group are the same grade, arrange them according to height, with the tall ones either in the center or at the ends, or occupying the rear row.

When you are arranging a large group in which about twelve or more persons are in each row, it is advisable to form them in a slight semicircle instead of a straight line (fig. 6-3). This places each person approximately the same distance from the camera and keeps the images a uniform size. Instruct each person to turn slightly so he or she is facing directly toward the camera.

The shorter the focal length of the lens used, the more pronounced is the distortion effect of apparent bending of a straight row. A proportionally greater distance exists between the center and the ends of a row with a camera having a short-focal-length lens than with one having a long-focal-length lens.

When the formal group is arranged and ready to be photographed, ensure each member is in the same relative position, hats are at the same angle, and uniforms are correct and neat. See that the hands and



302.275

Figure 6-4.–Formal group photo.

feet of all members are in the same position. When the front row is seated, the feet may be crossed but all in the same direction. Each person should be looking at the camera, no broad smiles, just pleasant expressions. Nothing should be so different about one person that it draws an excessive amount of attention. Remember, to get maximum depth of field, you should focus the camera one third of the way into the group (if there are nine rows, focus the camera on the third row).

As with everything else there is a time and place for formal group shots. What would happen, though, if you "stylized" the shot just a bit? Instead of always shooting the group setup that clearly identifies each member in the typical "lineup" by grade or height, why not think of your group picture in terms of your other photographs? Put in some foreground or a background. Use an interesting bit of lighting or a somewhat different setting. After all, do your subjects really have to be shoulder-to-shoulder? Do not forget the frame approach; it can work for group shots too. The group can be placed in a situation that has some relation to it. Foreground objects can be used to create a frame for a group of people in a photograph. Even one of the group members-the squadron commanding officer-can be your foreground; the rest of the officers can be scattered throughout the background.

The success of a formal group photograph (fig. 6-4) is dependent on your ability, as a photographer, to direct the members of the group so you can obtain the composition desired. Never hesitate because of grade to request members of the group to change their expression or position or to correct a discrepancy in their uniform. Be diplomatic about it, of course, but do not let the matter go unattended. It is embarrassing and a waste of valuable time to call a group together again to retake a picture regardless of the reason for failure.

The most important lesson a novice photographer can learn about photographing groups is how to remain in charge. Unless you are very careful the group will take control, and getting all the members of the group to look at the camera at the same time becomes almost impossible. Unless you are the dominating type, maintaining control is not easy. Remember, you cannot make good group pictures unless you are in control of the situation. To be in control, you should keep talking to members of the group and monitor their behavior. Have your equipment ready so you do not waste time or lose the group's attention while you load film or reposition the camera and lights. When you talk to people, they will naturally look at you, and therefore at the camera. Your directions and "patter" also prevent them from getting a word in edgewise among themselves. You must be firm when it comes to arranging the group. Do not be afraid of moving people about and telling them where to stand. Remember, you are making the pictures; you can see best what the final result will look like.



PHC Ronald J. Oliver
302.276

Figure 6-5.–Damage control trainee struggles to repair a ruptured pipe.

PEOPLE IN ACTION

When you photograph people in action, such as in sports and at work, the name of the game is anticipation, staying alert, and expecting the unexpected. Covering action events becomes an exercise in "guesstimating" where the action will take place and firing the shutter at the right moment.

A good action photographer relies on his knowledge of the event taking place; for example, if you will be photographing a General Quarters (GQ) drill and the principal players are going to be the Hull Maintenance Technicians, you could take a crash course in the job they will be performing during GQ. You might even observe them going through the drill a day or two before it is time to photograph them. Like a sports photographer-you must know the rules of the game. Even if you cannot learn the game, a photographer that understands the principles of shooting people in action can do a good job by following a few simple rules:

- Anticipate the action. Watch for the unexpected moment.

- Know the mechanical functions of your camera equipment. Practice aiming, focusing, and shooting until they become reflex actions. This leaves your mind free to concentrate on the event.

- Learn something about the action you plan to photograph.

The best pictures of people usually have action, implied or apparent. The action should be appropriate to the subject of the picture. The cook, for example, should not be shown in the boiler room (unless for a special reason or effect). Even a posed picture can have plenty of action and interest and not seem at all posed. Artificial, stiff effects kill the picture. Avoid static, dull pictures of groups staring directly into the camera Plan and shoot for action, such as applause shots or a speaker making gestures, or shots of an audience's facial reactions. Break up the overall scene into small groups of action, such as shots of important persons talking, the guest of honor shaking hands with others, and so forth. Even an attitude or arrangement of hands, feet, head, and shoulders often creates action. There is action in everyday living, in working, eating, drinking, smiling, arguing, driving, flying, sailing, and swimming. It is not so easy to capture action in still photographs, but by understanding the importance of action in a picture and the abundance of action available everywhere, you will soon become proficient at recognizing and picturing it. The blur technique has become popular for advertising and illustration use. Panning the camera with the action of a moving subject keeps the subject fairly sharp while blurring the background in a horizontal sweep, and this gives the feeling of action. A slow shutter speed is needed. Try the technique and see the interesting results.

A photo should have emotional mood and impact that can be accomplished by actual movement of a physical nature. The head may be raised in victory or joy or lowered in despair and sadness. The body sagging or the body squared away indicates different moods. Arms on the hips can indicate swagger, arrogance, or confidence. Hands in pockets indicate relaxation, or at the sides, may show formality. Knowing the elements of action, how to recognize them, and what moods they convey permits you to click the shutter at the right instant when you recognize outstanding action happening. The shooting angle, lighting, and composition all contribute to a feeling of action.

Action should always be photographed at its peak (fig. 6-5). This is a matter between the photographer and the photographer's own well-developed sense of motion. A highly capable photographer knows with certainty, at the instant he or she shoots, whether the picture will be a good one or not. This does not come from occasional picture taking but from steady, continual practice.

COMMAND FUNCTIONS

The majority of the job orders your imaging facility receives will probably be in support of providing photographic documentation for command functions. Photographic assignments that fall into this category are as follows: reenlistments, retirements, change of commands, awards presentations, and VIP (Very Important Person) visits. Some of the larger imaging facilities provide a photo mailer service whereby amateur photographers take snapshots of their command functions and forward the film to the imaging facility for processing. For those Photographer's Mates that are fortunate enough to cover these photographic assignments, high quality and professional service and products are imperative for the continued success of customer service and satisfaction.

To provide the best photographs possible, you must apply all of the principles and techniques discussed previously in this TRAMAN. Proper planning, composition, and lighting must be applied regardless of how routine you feel the job may be. Some general guidelines are as follows:

- Always use bounce flash whenever possible.



302.277

Figure 6-6.–Award presented by the former Secretary of Defense Frank C. Carlucci

- The reenlistee, retiree, or person being advanced, promoted, or receiving an award is always the subject (fig. 6-6). Regardless of who is presenting the award or conducting the ceremony (whether it be the division officer, commanding officer, or the Secretary of Defense), the recipient is always the center of interest.

- Avoid profile photographs of the subject. If necessary, shoot over the shoulder of the person presenting the award or conducting the ceremony.

- Prevent objects from giving the appearance of protruding from a person's head or body, such as pipes, flags, or doorframes. Always view the entire subject through the viewfinder and adjust your camera angle or viewpoint as necessary to prevent this compositional flaw.

- If you miss a shot or you know the photograph does not meet your standards, such as eyes closed, face hidden, or flash does not fire, always re-shoot the photograph. When it is not possible to re-shoot immediately, setup and re-shoot after the ceremony. When in doubt, re-shoot. Film is relatively cheap, but your reputation and the reputation of the photo lab is not.

- Never fake a shot. If you run out of film or have camera problems, make arrangements to take photographs at a later time. Better planning and improved communication will normally prevent this from happening.

CAPTION WRITING

Photographs, despite their unique story-telling ability, are seldom effective enough to stand alone. No matter how exciting the picture may be, it fails unless the viewer understands the five Ws-Who, What, When, Where and Why of the photograph. The area of providing information that the photograph cannot give is in the caption-the text that accompanies the photograph. It is your responsibility, as the photographer, to gather the necessary information and write complete, concise, and factual captions.

The caption supplements the photograph by answering the five Ws. It provides clarification of important details that are not readily apparent in the photograph, To make a caption work, you must use three basic elements:

- An explanation of the subject
- Identification of persons or things in the picture
- Additional details of background information

In caption writing, the first sentence is the most important. It must describe the action without overemphasizing the obvious. Always use the active voice of the verb and write in the present tense. Another important consideration in caption writing is background information. This consists of additional facts or explanations needed to clarify the photo. The amount of background information included depends on where the picture will be located and how it will be used.

Whether the photo will be printed in a military or a civilian publication, used in a report, or used as a display picture is of primary importance. The caption explaining a picture of a sailor wearing an oxygen breathing apparatus to a civilian is more difficult than explaining it to another sailor.

The second consideration, how the photograph is to be used, refers to whether it will be used alone, as a single picture, or used in conjunction with something else, such as a news story or report. When the picture is to accompany a news story or a report, the caption should not repeat details used in the text. On the other hand, when the photograph is to be used as a single picture, it must tell the whole story, and the amount of background information must be enough to provide the reader with all the necessary details. In other words, the caption and picture combination must tell the complete story.

The answers to the five Ws should be given in vigorous, forceful language without sacrificing simplicity and brevity.

WHO–Give as much information as possible about the personnel shown in the photograph, beginning with paygrade, rate, or rank and full name.

WHAT–Used to identify ships, aircraft, awards, and other things shown in the photograph.

WHERE–Identifies the location of the event.

WHEN–The actual time or date of the event.

WHY–The reason for a particular operation or action taking place.

The novice caption writer is often confronted with the problem of how long to make the caption. Although there is no prescribed length for captions, the general rule is one paragraph, preferably in 50 words or less. Caption content is your last opportunity to tell what makes a photograph significant. The shorter you make the caption and still tell a complete story, the better.

There is no best way to write a caption. There are, however, rules that make caption writing easier. One proven method is to make use of the three basic elements: **explain the action, identify persons or things in the photograph, and give necessary background information.**

EXPLAIN THE ACTION

The first of the three elements, explain the action, is the most important part of the caption. The very first sentence must link the caption to the photograph by describing the action. One of the peculiarities of the first sentence in caption writing is its verb form. Since a photograph has “frozen” a moment in time, the verb should be written in present tense. This provides a sense of immediacy, as though the reader is actually witnessing the event. For example:

> "Petty Officer Second Class Paul T. Boat swims through swirling flood waters of the St. Johns River to rescue 6-year-old Sammy Cameron . . . ."

This has more dramatic impact than a caption which reads:

> "Petty Officer Second Class Jane B. Doe swam through . . . ."

There is, however, one problem that arises from the use of present tense in the first sentence. What to do with the “when” or time element? If the when or time element is included in the first sentence, the result reads something like this:

> “Pete Rose hit a line drive to center field yesterday . . . .”

A sentence, such as this, would be somewhat jarring to the reader and should be avoided. To alleviate the problem, you should leave out the when or time element of the first sentence when writing captions, thus avoiding an awkward shift in tense.

IDENTIFICATION

The second element of caption writing, identification, frequently poses the question of who or what should be identified in the photograph. There is no magic formula to cover every situation, but the general guideline is to identify everyone or everything that is identifiable. and pertinent to the action. A pertinent individual or object is one that is involved in the central action of the photograph. In other words, anyone or anything in the photograph that attracts attention should be identified. Identification should come as early as possible in the caption. Many times you can identify people or things at the same time you describe the action.

> "BM3 Jack R. Frost sounds taps to climax Memorial Day ceremonies . . . ."

Here the action and the man are identified together. The only exception to placing names high in the caption is in the case of group identification. The recommended way to handle group photographs and still maintain reader interest is to use an impersonal identification in the first sentence; that is, "A group of sailors . . .," then list the names at the end of the caption. This method achieves complete identification without cluttering the all-important first sentence.

Identification in caption writing can be handled in any one of several ways. The idea is to handle it in the most natural and concise manner consistent with clarity. To ensure consistency, the caption writer generally uses four methods of identification:

- Action
- Obvious contrast
- Elimination
- From the left

Action is, of course, the best method. When a little league baseball player is sliding into second base, it should be obvious from the action which boy is the base runner; therefore, it is not necessary to say left or right as a means of identifying the players.

Obvious contrast is another simple way of identifying people in a photograph. If the commanding officer and an airman recruit are photographed, it is not necessary to identify the commanding officer as being left or right.

Identification by **elimination** is slightly more complex but nevertheless very effective. Suppose there are four people shown in a photograph. The commanding officer of the photo school is presenting a citation to a third class petty officer. These two are identified by the action. A third person, the petty officer's wife, standing alongside, is identified by obvious contrast. The fourth person, the award recipient's division officer, is then identified by elimination.

The fourth and least desirable method of identification is **from the left.** This method of identification should be used only as a last resort or when there is a chance of confusion from using any of the other methods, such as in identifying groups of people. When you use this method of identification, it is not necessary to say, "'From left to right." To do so only wastes space. Logic tells us that if we start from the left there is no place to go except to the right. The task is therefore simplified by saying, "From the left."

BACKGROUND INFORMATION

Background information is our third element of caption writing. It consists of additional facts or explanations needed to clarify the photograph. It is often impossible for the photograph and the five Ws alone to provide all the details necessary for a complete understanding of the photograph. Therefore, it becomes necessary to provide the viewer with additional information for the purpose of clarifying the photograph.

How much background information is needed to clarify a photograph depends on two factors: where the photograph is to be used and how it is to be used.

CREDIT LINE

The last part of caption writing is the **credit line.** The usual method is to credit both the photographer and the service. While there is not a set standard for giving credits, the following format can be used:

> Official U. S. Navy Photo by:
> PH2 Jack R. Frost, USN

Or the credit line can follow directly after the last word of the caption, as shown in the following example:

> Line handlers cast off the stem line as the amphibious force flagship, USS *Eldorado* (AGC-11) gets under way for a Western Pacific deployment. (Official U. S. Navy Photo by: PH2 Jack R. Frost, USN.)

A typical caption should also identify the unit that produced the photography and, if appropriate, contain a file number. As an example, a typical caption may look something like the following:

UNIT ID	PACIFIC FLEET IMAGING COMMAND SAN DIEGO, CA
DIVIN, MEDIA CODE, FY, SEQUENCE NUMBER; DATE OF PHOTOGRAPHY	N0108-SCN-93-00374 21 MAR 1993
CAPTION TEXT	Six-year-old Terry Thomas, a victim of. . . . Brenda has been doing . . .
CREDIT LINE	Official U.S. Navy Photograph by: PH3 Jon T. Boat USN

Your skill as a caption writer, like any endeavor, will improve with practice. When you write a caption, have the photograph in front of you. This may help you recall just what was taking place. Avoid phrases, such as-"Shown above," "This is a picture of. . . ." or "Posing for the camera . . . ." These phrases insult the reader's intelligence.

When writing captions, you should always be alert to point out interesting or important things in the photograph that might escape the casual reader. Remember to spell out the meaning of all unfamiliar abbreviations. PHAA may mean Photographer's Mate Airman Apprentice to you, but it may be meaningless to the reader.

Finally, you must remember that the caption should supplement the photograph, not duplicate with words what is readily evident in the photograph.

Captions should always be typed, preferably double spaced, on a separate sheet of paper, such as "crack-and-peel" stickers or plain, white paper, and affixed to the back of the photograph. When using plain, white paper to prepare and attach a caption to a photo, first type the caption on the bottom of a sheet of paper. Cut off most of the unused portion and fold just above the typing. Attach the caption to the back of the photo with tape so the typed caption folds over the bottom and lies against the face of the photo. When unfolded, the caption is properly positioned at the bottom of the photo.

INVESTIGATION PHOTOGRAPHY

Photography is a valuable tool used by the master-at-arms, the Naval Investigative Service, and other investigators to make visual records of crime scenes, accidents, or other incidents. Evidence (investigative or forensic) photography is used to show particular items of evidence and their relationship to the scene and to produce closeup pictures of significant parts of the scene.

As a Photographer's Mate, you usually will be working under the direction of an investigator when producing forensic pictures. However, you should take the initiative to learn all you can about the case you are working on. With sufficient information, you can use your judgment to assess the photography requirements, angles of view, supplementary lighting, close-ups, and other factors, such as camera, lens, and film choice. Investigators, especially in crime cases, are often reluctant to give the photographer any information. They would rather you not ask questions and just follow their specific directions of what to photograph. This is often the case because they do not want information leaks that could ruin their case. You must gain their confidence and not discuss the case with anyone outside of the investigative team. On many occasions, investigative leads have been developed solely by studying good forensic pictures provided by a professional photographer.

When photographing any scene as part of an investigation, it is important to make overall pictures of the scene that can be related to the close-ups which you must also take. These overall pictures are important and cannot be sacrificed for any reason. Use wide-angle lenses to obtain these views when you cannot move to a vantage point where a normal lens can be used. When making overall views of the scene, avoid having extraneous elements, such as people and automobiles, or other confusing elements included. Extraneous elements only serve to mislead people viewing the photographs and may obscure important details. Investigators will normally cooperate by clearing the scene for the overall views.

Never take it upon yourself to recreate the scene if it has changed before your arrival. Repositioning elements within the scene or having someone assume the position of a body that has been removed will not be of any help. There is no way of assuring accurate repositioning, and the photographs become suspect as being "contrived" and made up. You should always photograph the scene as you find it. If the investigator wants to recreate the scene, that is his business. You should not offer to help.

Closeup views of scene elements should be made of any evidence, weapons, aircraft damage, body wounds, and so on, before the evidence is moved. If, for example, a closeup shot is needed of a gun that was thrown under

a car, it should first be photographed before the car is moved. This overall or medium shot should show both the car in comparison to other scene elements and its relationship to the gun. Only then should the car be moved to get the closeup shot of the gun

Today, the trend in Navy investigations is to use color film because color photographs represent the subject more realistically than black-and-white film. People see their surroundings in color, and based on this premise, color photography has become completely acceptable for courtroom use. Color pictures convey a more accurate representation of the facts to the court or persons reviewing reports.

FIRE AND ARSON PHOTOGRAPHY

Fire fighters and damage control personnel realize the value of good photographic records of a fire and its damage in helping determine both the cause of the fire and the effectiveness of the methods used to fight the fire.

One of the most important functions of any group of fire fighters is training. The most effective training method is, of course, actually practicing fire fighting. However, aboard ship and because of the cost ashore, this cannot always be done. The next best method of training is with visual aids. By studying still pictures and movies of a fire, firemen and members of the damage control party can receive instructions and observe proper procedures in the performance of their duties. Photography serves as a means of refreshing the memories of fire fighters and witnesses during the investigation of a fire.

Fires aboard ship and ashore should be photographed from the time the fire party arrives to the time the tire is out. Pictures of the fire should include overall views showing the positions of trucks, ladders, hoses, other types of equipment, personnel fighting the fire, and people watching the fire. Pictures of the progress of the fire must also be made. Fire progress pictures should show the structure, smoke, and flames.

Arson is becoming a big business in the civilian world. As sailors, we do not see much arson in the Navy, but there have been cases and will continue to be cases of arson in the Navy. We cannot afford to have an arsonist in our midst, particularly aboard ship or in the barracks.

Without evidence, arrest and prosecution of an arsonist is extremely difficult. Photography is an effective tool in recording and preserving the evidence of set fires. Much of the actual evidence may be destroyed during fire fighting, or if it survives the fire, it may be impossible to preserve.

Every effort should be made to photograph the scene of a fire, whether or not arson is suspected, before it is disturbed by other operations. You must work fast, but never do a careless job. Your pictures may be used to prove the intent to commit arson.

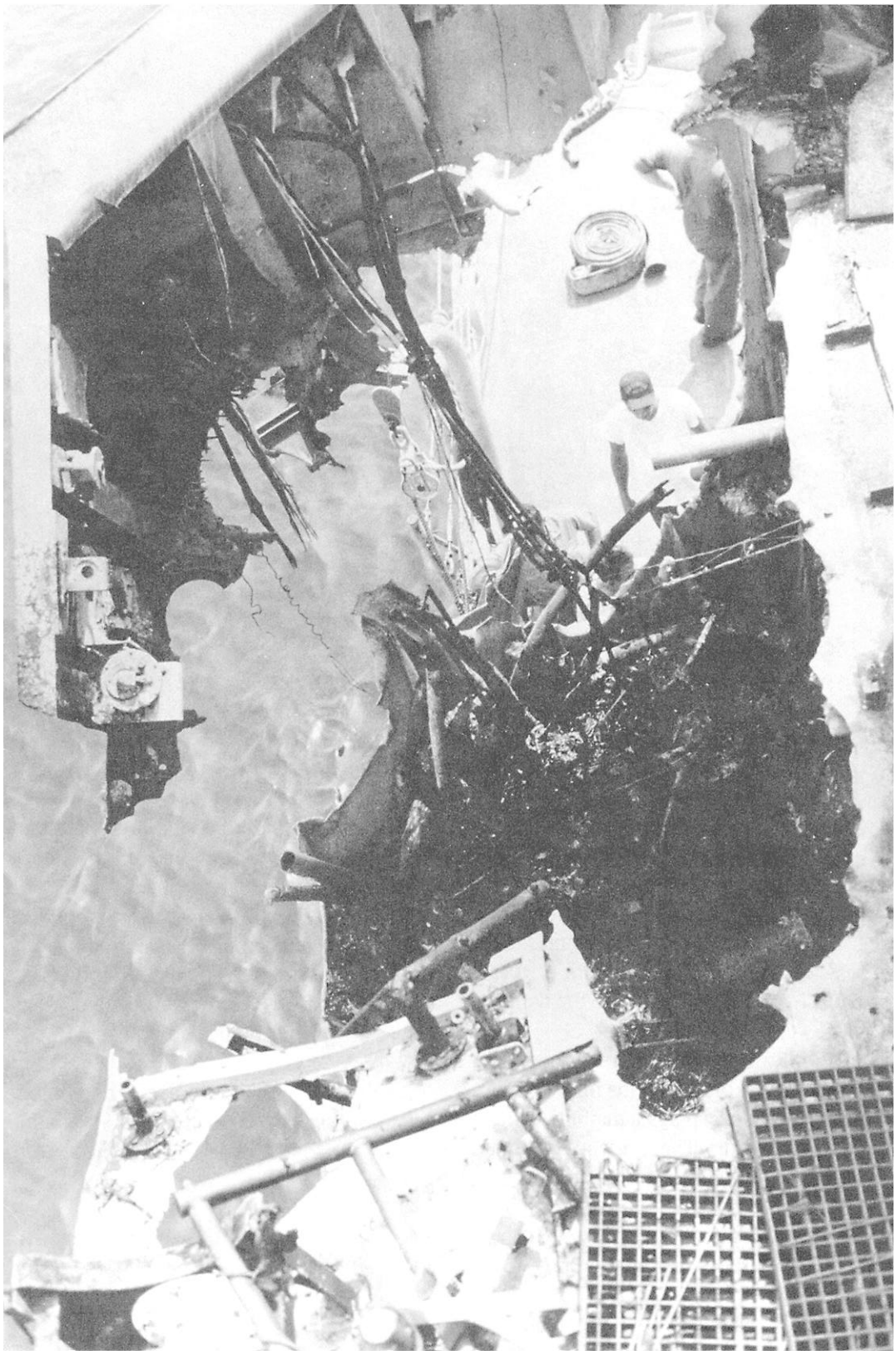
The pictures you make of a fire should do the following:

- Show the area or areas in which the fire started or was set.
- Help identify spectators. An arsonist often remains to watch the fire.
- Provide information about the speed of combustion and direction of spreading.
- Show the progressive stages of burning and fire fighting from various angles. If possible, keep a record of the time each picture was made.

Help investigators determine the type of material burning. This is where the use of color film is recommended. The steam, color, and quantity of smoke and the color and size of flames are indications of what type of material is burning. The color of the smoke often indicates whether an accelerant, such as gas, was used to speed the burning.

Once the fire is out, pictures (fig. 6-7) are made of the rubble. Give particular attention to the most burned or charred areas. The structure should be photographed from all sides to show the damaged areas. Other things to look for are incendiary devices and combustible materials, such as matchbooks, paper, liquids (such as gas and paint thinner), and fuses. Although they may have burned completely, there could be a visible trail, defective wiring, and electrical or gas appliances that may have been the cause of the fire.

The exposure required to photograph the interior of a building after a fire may be considerably more than indicated by normal exposure calculation methods. So much light is absorbed by blackened and charred areas that it may be necessary for you to open up several stops over your indicated exposure, even for well-lighted close-ups. When using flash to light burned areas, hold the flash away from the camera to permit some improvement in the rendering of texture. This will bring out the alligator or checked pattern of burned wood, blistered paint, and so forth.



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Figure 6-7.–A close-up damage to the USS *Stark* after it was struck by Iraqi-launched Exocet missile.



LT Gary A. Phillips
302.279

Figure 6-8.–Crew members aboard the USS *Forrestal* fight fire on the flight deck.

AIRCRAFT ACCIDENT INVESTIGATION PHOTOGRAPHY

Every aircraft accident (fig. 6-8) affects readiness to some degree, and with the cost of equipment rising steadily, the loss of one of our first-line aircraft represents a serious loss to the Navy and to the national economy.

Aircraft accident investigation is one of the fundamental elements in a program for the improvement of aviation safety. Photography plays a major role in an aircraft accident investigation. The evidence obtained through photographs will help determine steps to prevent similar occurrences.

To make the most useful photographs, you must clearly understand the purpose of photography in an aircraft accident investigation. It is NOT to assess blame, nor is it solely to establish a single or primary cause factor. Few accidents result from a single cause. In most of the accidents, a sequence of events occurs. The elimination of any one of these events may have prevented the accident. Therefore, to prevent future occurrences, you must consider all possible cause factors and photograph them, if possible. An incomplete photographic record of the investigation may result in erroneous conclusions and nullify the only possible benefit that could have been derived from a costly accident. The photography surrounding an aircraft accident is a methodical accumulation of small bits and pieces of information that eventually form a pattern. The wreckage itself may contain valuable evidence that, if correctly photographed, may provide these certain cause factors.

Successful aircraft accident photographers have certain essential characteristics in common. You must apply the following essentials of good aircraft accident photography to your work:

1. Promptness-Get to the scene of the accident immediately-before the evidence is disturbed.

2. Thoroughness-Photograph all evidence in minute detail. Operate on the assumption that there is no limit to the amount of photography justified to prevent the recurrence of one aircraft accident or the loss of one life.

3. Organization-Conduct a planned photographic survey.



Jim Bryant
302.280

Figure 6-9.–News reporters photograph damage incurred when a T-2C Buckeye crashed into the superstructure of the USS *Lexington.*

4. Accuracy–Pictures that show half-truths are unacceptable in aircraft accident photography. Do not make pictures that hide detail or distort the scene. Remember, all photographic evidence must be accurate.

It is nearly always necessary to crawl around or under the aircraft wreckage to get pictures. You should arrive at the scene appropriately clothed in a complete, comfortable working uniform, which you do not mind soiling.

Procedures at the Scene of the Accident

Current OPNAV instructions specify that the surviving crew members (if physically able to do so) or the first military personnel arriving at the scene of an aircraft accident must take charge until relieved by proper authority. At the scene of the accident, you will be working for the officer in charge (OIC). You report to and receive your orders from the OIC. In many cases, it may be possible for you to accompany the crash rescue party to the accident. The sooner an experienced and qualified photographer can get to the scene of an accident, the better the possibilities of acquiring more valuable photographic evidence. You should commence taking pictures immediately upon arrival. Pictures made before extensive fire damage can reveal information that might otherwise be lost.

Safety of personnel involved is of primary concern in every aircraft accident. Rescue operations and removal of occupants from the aircraft should be among your first photographs. When medical treatment is being given to survivors of the accident, photograph it not only for documenting the treatment but for the purpose of isolating factual information on human failure. Casualties should also be photographed in the positions they occupy when you arrive on the scene. Photographs of the dead should be made to show the location of the wreckage and the position of each body in relation to it.

You should be advised of any classified material involved, and it should be either covered or removed before photographs are made unless it is important to the accident investigation. This is a situation where close liaison with the OIC is absolutely necessary.

News reporters may gather at the scene and because you, as a photographer, have something in common with them, they will naturally seek you out. Do not attempt to tell a reporter what to write. Do not make a statement, express an opinion, or provide information about the accident (fig. 6-9).

Photographic Record

In almost every accident, a certain minimum number of photographs is usually required. These apply to automobile, motorcycle, personal injury, or any type of accident.



PH2 John Gay
302.281

Figure 6-10.–USS *White Plains* is blown hard aground at Polaris Point, Apra Harbor, Guam.

A complete photographic record should include photographs of the general terrain or site of the accident, overall views of undisturbed wreckage, reconstructed components or systems, and closeup views of important or significant structural or other material failures. The terrain pictures should show any surface irregularities, presence of damage to buildings, trees, or other objects, point of first contact, impact marks, and so forth. The photographs should be made as soon after you arrive at the scene as possible, since subsequent investigation work or other conditions may alter or destroy the evidence. After the terrain pictures have been obtained, you should concentrate on photographing the undisturbed wreckage. The emphasis here should be on showing the attitude of the aircraft or vehicle at the point of impact, the general extent of damage, and the presence or absence of all major components, such as the wings, stabilizers, elevators, rudder, and ailerons. When fire indications are found in various areas of the wreckage, show these indications together with any corresponding indications of tire in the surrounding area. These later photographs can often be used to substantiate findings of ground fire versus in-flight fire. Other points that appear to be significant from a preliminary examination should be recorded before the detailed wreckage examination is begun. Very often the investigator decides to reconstruct or rearrange particular parts of the wreckage to determine failure patterns. A photographic record should be made of such reconstruction work to assist in the subsequent evaluation. Finally, closeup views of important structural failures should be included in the photographic record.

In general, the photographic record should be complete enough to permit a person who is reviewing and evaluating the accident report to appreciate the

significance of the investigator's finding. While the investigator's report must contain a detailed write-up of the damage, it is still true that one picture can often take the place of many words (fig. 6-10). The investigator should use photographs as another tool in complete and accurate reporting. Each photograph included in the report should purport to show a separate point or detail relative to the accident.

When evidence is to be presented, get a good picture of it. You are not a mind reader and cannot be expected to get the pictures that are contained only in the investigator's mind. Normally, you must ask the investigator exactly what is to be photographed.

Pertinent photographs of the following details are always required:

- General view of the scene along the wreckage pattern to the point of first contact.
- Aerial view of the accident scene (aircraft).
- Damage to objects struck
- BUNO or license plate.
- All major parts of the wreckage.
- Detailed view of the cockpit, instrument panels, switch settings, and control handles (aircraft).
- Engines and propellers.
- Wheels and landing gear assemblies (aircraft).
- All parts involved in, or suspected of structural failure, or of having contributed directly to the accident. These photographs should have sufficient detail to show the grain of the metal at the failure point or other detailed information, such as the direction of shear of the rivets.
- Any failed part that has been established as the cause of the accident or is believed to be significant to the cause of the accident should be photographed in detail.

When photographing small, important pieces of evidence, the parts should not only be photographed in the field but they should be removed from the scene and photographed in the studio under controlled conditions. This ensures that the photographs of the items in question are clear and well defined. It is a good practice to photograph the failed part and an undamaged like item in the same exposure so the failure is readily apparent.

To avoid confusion, you should assign all aircraft accident photographs exhibit numbers and carry descriptive captions to point out the details of evidence to which they contribute. A picture without an explanation is confusing and worthless.

Each aircraft accident photograph should be readily identifiable, and to ensure this necessary requirement, you must identify all photographs with the following information:

- Date of accident
- Location of accident
- Type of accident
- Type of aircraft
- BUNO of aircraft
- Part and part number (where applicable)
- Squadron
- Aircraft accident report number

Special handling note according to OPNAVINST 5290.1

At a minimum, the following items should be included in your camera bag for an accident or arson scene:

1. Camera and normal lens
2. Wide angle and telephoto lenses
3. Flash unit and extra batteries
4. Large amount of color and black-and-white film
5. Extra sync cord for the flash
6. Flashlight
7. Note pad and pen
8. Macro lens or closeup filters
9. Surgical gloves
10. Ruler
11. Tape measure

PRODUCT PHOTOGRAPHY

Product, or illustrative, photography is used to show and explain an object more completely and concisely than is possible with words alone. By using the photographic medium, it is possible to illustrate a variety of items to show size, shape, location, and condition. In the Navy, product, or illustrative, photography is used to show new equipment-from ships to pencil sharpeners and from buildings under construction to damaged

aircraft. It is used extensively to show damaged, defective, and unsatisfactory equipment-from aircraft engines to zippers.

The discussion on illustrative photography in this chapter is limited to those aspects that apply to studio work. In this sense, illustrative photography should be considered as product photography. The techniques given here are not necessarily "locked up" in the studio. They can be taken outside the confines of the studio and put to good use in the field.

Product photography, then, is the making of photographs for the purpose of illustrating or explaining something about a product, either in whole or in part.

EQUIPMENT

The three types of format cameras and the lighting units used to accomplish product photography are discussed in this section.

Camera

The variety of subjects encountered in product photography requires a camera with a long bellows extension, vertical and horizontal swing adjustments, tilt, rising front, and lateral shift and both long- and short-focal-length lenses. All of these features exist on a view camera.

The view camera is the primary tool of professional product photographers. An 8x10 view camera is usually the largest size in use today. Photographers that want to produce the highest quality photography use it. Its large film format and adjustments help to produce clear, sharp, nearly distortion-free photographs that are in complete focus.

Large film-format cameras provide high-quality images because the negatives or transparencies do not have to be enlarged as much as smaller negatives. A large film format in and of itself does not necessarily ensure high-quality product photography. Long tonal range, from highlights to shadow detail, is required. Lighting ratios must be calculated and adjusted with care, and exposure calculations must be precise. Lenses of the highest quality, which are spotlessly clean, enhance the photographic quality of any size format.

VIEW CAMERAS.–Most Navy photo labs do not have an 8x10 view camera; but most of them do have a 4x5 view camera, and you should use it for most product photography. Whatever view camera you use, it **must** be supported on a steady tripod.

MEDIUM-FORMAT CAMERAS.–If for some reason, such as a need for speed or limited working space (such as inside the cockpit of an aircraft), a view camera cannot be used for product photography, then a medium-format camera should be your next choice.

> **Some photographers choose other than a large format camera simply because they are willing to sacrifice quality for convenience, rather than use a view camera. They probably have the attitude of "it's good enough for government work." Do not fall into this trap. Instead, always strive to produce photography of the highest professional quality. As we have said before, you will be known by the quality of your photography more than anything else. Maintain the attitude that "nothing is too good for the Navy."**

Medium-format cameras can be hand-held, focused rapidly, and many images can be produced in a relatively short time. The film size, however, is not as conducive to high-quality photography as the 8x10 or 4x5 formats. The main disadvantage of a medium-format camera for product photography is its lack of adjustments to correct distortion.

35MM CAMERAS.–Finally, we have the small format, 35mm camera. Because of its small film size, many photographers do not even consider it for use in product photography, particularly in the studio. It does, however, have its place in product photography, particularly when a large number of exposures must be made in rapid succession or when working space is very limited; for example, inside the intake ducts of a jet aircraft.

Which of the three format cameras-large, medium, or small format-should you use for product photography? There is no **best** camera to use; there is, however, only one **best** camera to use for each assignment, and you must be able to choose the one that best meets the needs of the photographic assignment at hand.

Lights

The lighting equipment most commonly used for product photography is incandescent lamps and electronic flash or strobes. All lighting units have one or several of the following means of controlling light: reflectors, lenses, barn doors, diffusers, snoots, umbrellas, or reflector boards.

SPOTLIGHTS. –Spotlights are one of the most important lights in small product photography. They produce light with a relatively high intensity and a well-defined, sharp quality. The rays of light produced by the Fresnel lens of the spotlight sharply separates the highlights from the shadow areas. A spotlight can create a visual sense of subject shape and bulk. When used in a skimming or crosslighting fashion, it renders sharp, crisp texture. Because the light rays are collimated, or parallel, with little flare or spillover, a spotlight produces high contrast. One great asset of spotlights in product photography is the controllability of the lights. The light can be controlled to highlight or isolate an area of the subject. Unwanted spillover into other areas can easily be avoided. Through proper use of accessories, such as snoots and barn doors, the control can be greatly extended. A disadvantage of spotlights is the harsh quality of highlights produced on some subjects. Bright spots on the subject may be pinpointed and hard to avoid. Nonetheless, a spotlight is a most effective main light for product photography.

FLOODLIGHTS.–In product photography, floodlights are used to cover a large area with relatively even illumination. The quality of light from a floodlight is very much dependent on the reflector surface. Polished, metallic reflectors produce a specular, sparkling quality, while matte-surface reflectors produce a softer quality of illumination. The quality of illumination from a floodlight is also dependent on its distance from the subject. At a given distance, the spread pattern for a given light unit is almost even. Some units may produce hot spots when used too close or too far from the subject. The larger the reflector and the closer it is to the subject, the more diffused the light becomes.

BOUNCE LIGHT AND UMBRELLAS.–The use of bounce light for product photography produces a pleasant quality. The light, because it is coming from one general direction, not an obvious source, surrounds the subject with soft illumination, gently enhancing curves and shapes while producing soft but distinct shadows. Bounce light can be used for either overall illumination or as fill illumination.

Umbrellas, being large and somewhat parabolic in shape, are more efficient than plane or board reflectors.

FUNDAMENTAL PRODUCT LIGHTING

Given a product assignment, you must determine ways to photograph or present the subject best. Aside from product arrangement and picture composition, which must lead to an understanding of the purpose of the picture, you must first deal with the lighting. By the correct use of light, you can create a natural lighting, which is attractive, and simulates outdoor light. In product photography, you should always strive to produce lighting that appears natural, as though the product was illuminated by natural sunlight. After all, it is natural daylight by which all light is judged. Illumination from the main light should come from above and somewhat behind the subject, usually from about a 40- to 60-degree angle. In many commercial texts the main light is also referred to as the key light; these terms are used interchangeably by professional photographers. There should be one definite light source and only one set of dominant shadows, and the shadows must be illuminated sufficiently so the shadow detail is maintained in the film image. In a naturally lighted outdoor scene, this shadow detail is preserved by general skylight illumination. In the studio, this shadow detail is preserved or created by the correct use of soft, diffused, fill lights or reflectors.

In the studio, you can create the lighting effect of an overcast sky with a light tent or by using indirect lighting. This type of lighting is especially useful when you are photographing shiny products, such as bare metal and glass.

Backlighting is one of the essential tools in product lighting. Establishing the main light behind the subject often helps present three-dimensional form better than frontlighting. Aside from the subject being rimmed with light, which separates it from the background, the foreground shadow duplicates the shape of the object, making it easier to identify.

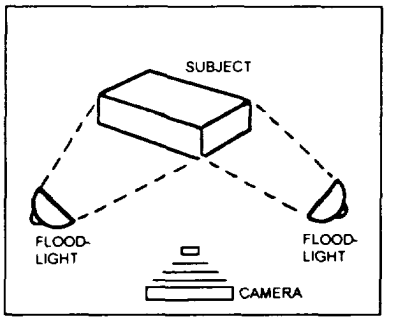
LIGHTING BASIC SHAPES

Most small product items fall under two basic or general shapes: rectangular and spherical. The illustrations in the following paragraphs show ways that basic lighting can be used to present shape. Although a perfect rectangle and a perfect circle are used in the illustrations, they are not intended to limit your lighting setups. You must, of course, make lighting adjustments, depending on how rectangular or spherical the subject is and the way you want to present it.

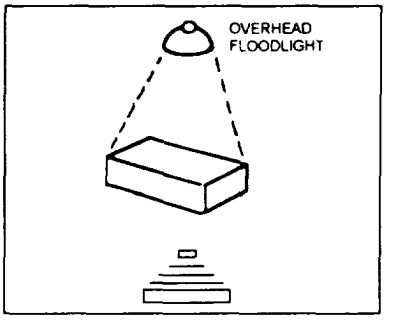
Lighting Rectangular Shapes

Rectangular- or box-shaped products can be lighted with just three lights-a spotlight from the rear and two floodlights, one on each side of the camera.

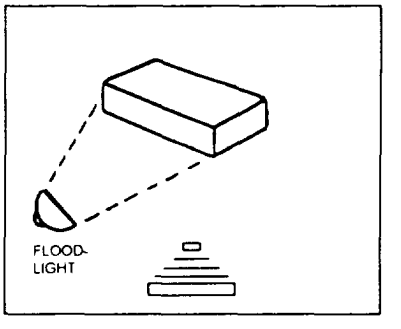
Two floodlights, one on each side of the camera., at camera level “flatten” the subject.



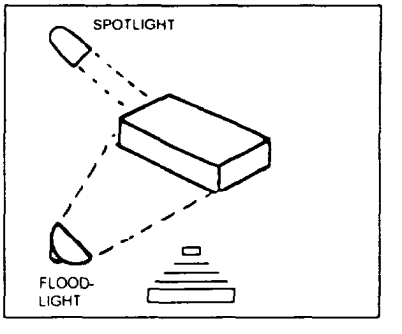
Diffused light from above does not help. There is no contrast between the two front planes.



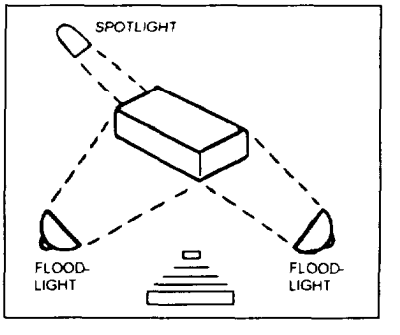
Instead, start the lighting slowly, one light at a time. Here the left-front floodlight starts the lighting.



The spotlight from the rear is established.



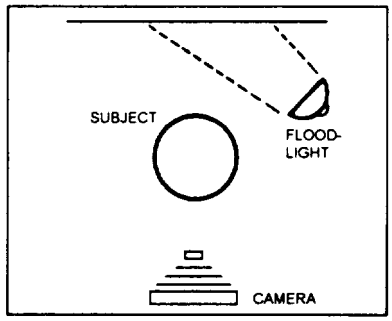
Now add the third and final light. This is the right-front floodlight that should provide only about half the intensity produced by the other floodlight. Notice the background shadow and the way it helps to separate the subject from the background; also, notice each plane of the subject has its own tonal quality, giving it shape and form. The foreground shadow, besides helping to visualize shape, tends to hold the block to the ground.



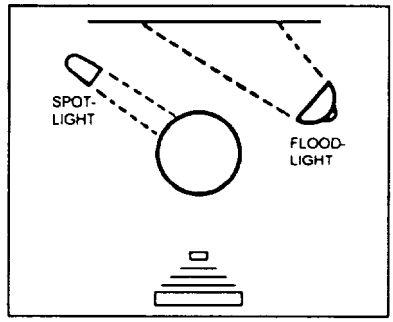
Lighting Spherical Shapes

Spherical- or round-shaped products can be just as simply lighted, but this time the basic setup requires five lights.

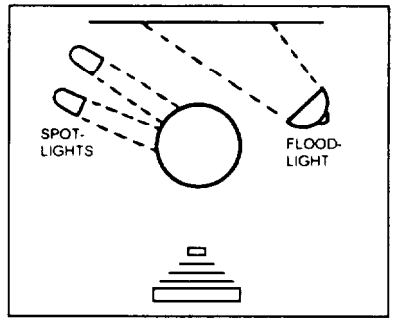
With only the background lighted and no light falling on the ball, the ball appears as a hole cut in the background paper.



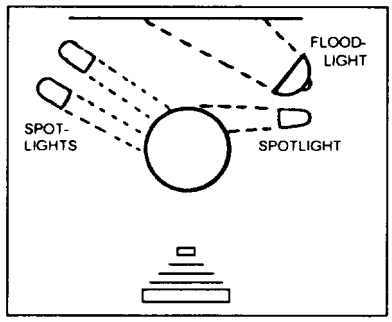
To light a round object, start the lighting setup by first establishing the main spotlight high, behind, and to the left of the subject.



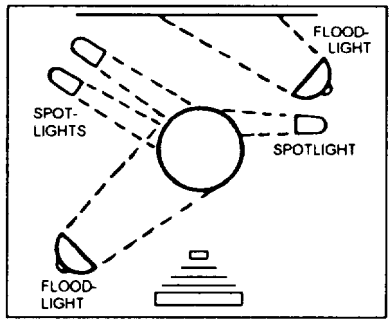
Add a smaller spotlight at subject level in a position at the left rear of the set.



Adding a low, third spotlight from the right rear forms a bright highlight in the top of the area lighted by the main light. This adds a sense of roundness to the ball.



The final light in the setup is a weak fill-in light that changes the effect and produces a fully lighted ball that shows maximum shape, form, and texture.



Through experience, you will learn what effects to expect from lighting. Good lighting is created through an orderly, thought-out process involving several steps that should be taken in chronological order:

1. **Previsualize.** You should form a mental picture of how the subject should look What should be shown? What part of the subject should be featured or be the center of interest?

2. **Determine** what type of lighting to use. From what direction should the main light come? Where should the fill lights be located? From what distance should the light come?

3. **Select** the equipment that can best do the job. What camera 4x5 inch, 8x10 inch, 2 1/4 inch, or 35mm? What kind of lights-strobe, incandescent, flood, or spot? What accessories are needed-reflectors, barn doors, umbrellas, and so forth.

4. Establish the lighting. Is the key light doing what you want? Would another light do a better job? Is there enough shadow detail? Is more or less fill light needed? Are there too many highlights and are they in the right places? Are the highlights too bright? Do each of the lights add to the overall quality of the lighting, or can some of them be eliminated? Will the subject record on the film as previsualized?

5. Determine the exposure. What should be the exposure for the highlights and the shadows? What is the correct exposure for the overall set? Will the film record the contrast range between important highlights and shadows?

6. **Check** the set. Is light spilling onto the camera lens causing flare? Is the composition as it should be? Are important details obstructed?

7. **Expose** the film.

CREATING THE LIGHTING

For most product photography, the first light to be placed is the main light, then lights to create highlights are added, and finally any fill lights. However, the order in which the lights are placed depend somewhat on the subject to be photographed. When, for example, the product is tented, the procedure should be to establish an overall, high level of illumination first. Other lights should then be added to better show shape, form, and bulk of the subject.

You should always start your lighting setup with the main light. The usual position for the main light in product photography is high and somewhat behind the subject. The position of this light is very important. To establish this light, you should do the following:

1. Darken the set.

2. Through the camera ground glass, view the effect of the main light on the subject. Have an assistant move the main light in the general area previsualized for the main light. Establish the main light in a position where it produces the most pleasing and desired effect. Remember, the farther the main light is from the subject, the smaller the highlights and the sharper the edges of the shadows. As the light is moved, notice the change in highlight and shadow areas. It is important for you to observe the effect of the lighting (through the ground glass) exactly as the camera will see it. The characteristics of the main light greatly influence the overall quality of the picture.

3. Add secondary spotlights as needed to create highlights and texture. Highlights other than those produced by the main light may be needed to help separate and define subject planes as well as to separate the subject from the background or its surroundings. By using secondary spotlights in a crosslighting or skimming manner, you can emphasize the surface texture of the subject.

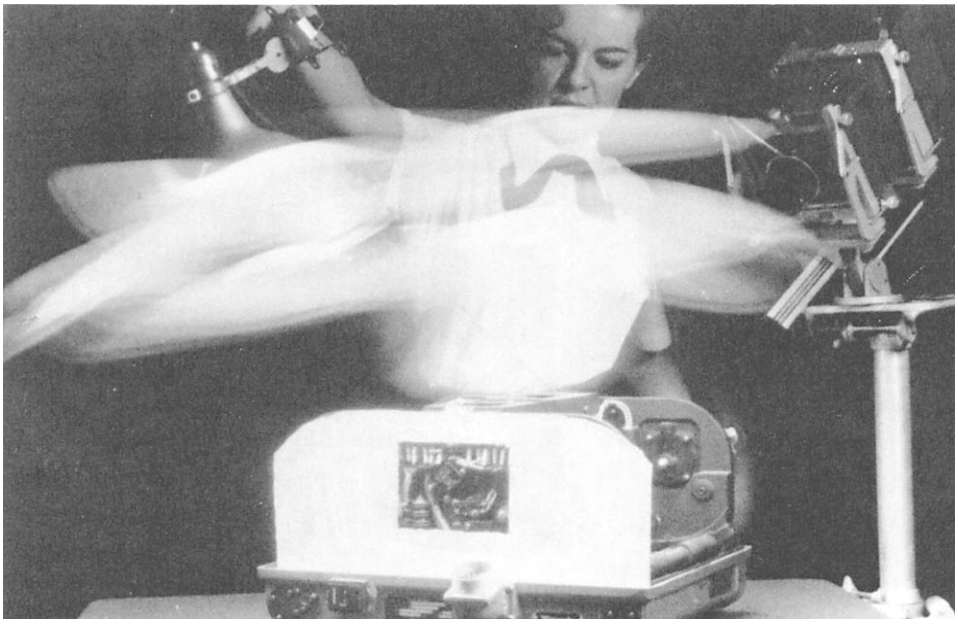
Establishing the secondary lights to produce the desired highlights and texture is more time-consuming than positioning either the main or the fill lights. When the subject is a complex shape or has many planes, several small, secondary lights may be needed.

4. And finally, once the main light and highlights have been established, the fill-in illumination is applied to provide the appropriate shadow detail. The fill light illumination is usually supplied by one or more diffused floodlights or reflectors. Care must be taken to ensure that the fill-in lighting does not cast distinguishable shadows. This problem can generally be solved by positioning the fill lights close to the camera and at a low angle or about tabletop height.

Every light you use in product photography should have a definite purpose in creating the final photograph. A dominant light source must prevail without undue competition from other light sources. If the addition of a new light creates new problems, then start over again. Remember, the simplest approaches to product lighting are the best.

Lighting Ratio

Whenever you light the set for small product photography, you must keep lighting ratios in mind. A



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Figure 6-11.–Using painted light.

useful range between highlights and shadows, in which the film can record detail, must be established. This useful range depends completely on the reflectance range of the subject.

With most color films, this range between highlights and shadows must be kept within five f/stops. This means a ratio of about 32:1. Any area of the subject (except specular highlights) that is outside of this range is reproduced either too light or too dark in the final picture. A reflected light meter can be used to find the relationship between the useful or desired diffused highlight and the darkest desired shadow. A difference of two f/stops is a scene contrast of 4: 1; four stops is a 16:1 contrast. Most black-and-white film can record both highlight and shadow detail when this range is not greater than about six f/stops.

Painted Light

Painted light (fig. 6-11) is one of the best ways to obtain even illumination and soft shadows. With this type of lighting, only one light is used. The light is moved constantly up and down and around the subject and its background. Painted light is effective for illuminating subjects made up of many smaller parts that cast shadows onto adjacent parts, such as printed circuits or the inside of a radio.

When you are using the painted light technique, the exposure must be increased by a factor of 3. To determine the painted light exposure, hold the light stationary at the same distance it will be used from the subject. Read the exposure with your light meter. Multiply the exposure time indicated by the meter by 3, the painted light factor.

Example: With the light meter, you have determined the exposure to be 6 seconds. Multiply the exposure time, 6 seconds, by the painted light factor, 3 (6 x 3 = 18 seconds).

The minimum exposure time required when using painted light is 10 seconds. An exposure of less than 10 seconds does not give the photographer enough time to illuminate the subject evenly.

PRODUCT PHOTOGRAPHY TECHNIQUES

Product photography requires patience and a keen eye. The slightest change in lighting or subject placement can add to or subtract dramatically from your photograph. Pay particular attention to small details of your photograph because this helps to provide sharp, high-quality images with fine detail.

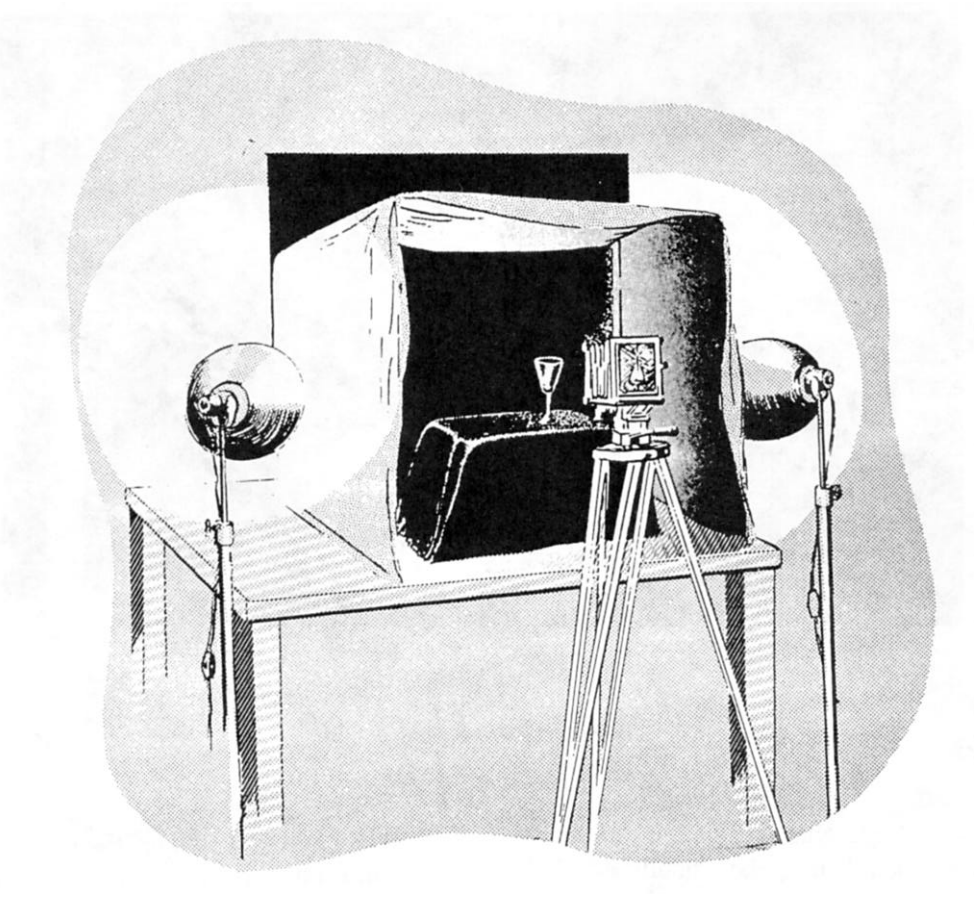


Figure 6-12.–Tent lighting setup.

TENTING

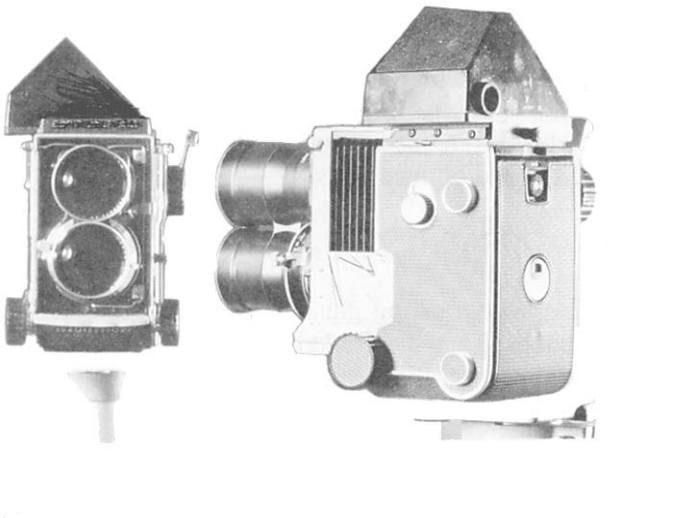
Photographing small products can be quite difficult if they include bright reflective surfaces. You can easily see other nearby objects reflected in them and sometimes even the whole studio. Also, light from the lighting units may reflect off the surface very strongly at a particular point. This can create an unwanted bright highlight. There are two ways to get around these problems. You could use many lights and add reflectors to make sure the lighting is even. This may solve the problem of light from the lighting units reflecting off the subject surface, but unfortunately there are two great disadvantages: it requires more lights than most photo labs have, and you still have reflections. The other way to solve the problem is to use the tenting technique.

The tent consists of a frame covered by a translucent white material that casts a diffused illumination on the subject (fig. 6-12). The lights are placed outside the tent and directed onto the translucent material. The color of the background, which is placed inside the tent with the subject, depends on the subject and the effect desired. Strips of black or colored paper taped to the inside of the tent add the necessary dark accents or "bring to life" a colorless object.

DULLING REFLECTIONS

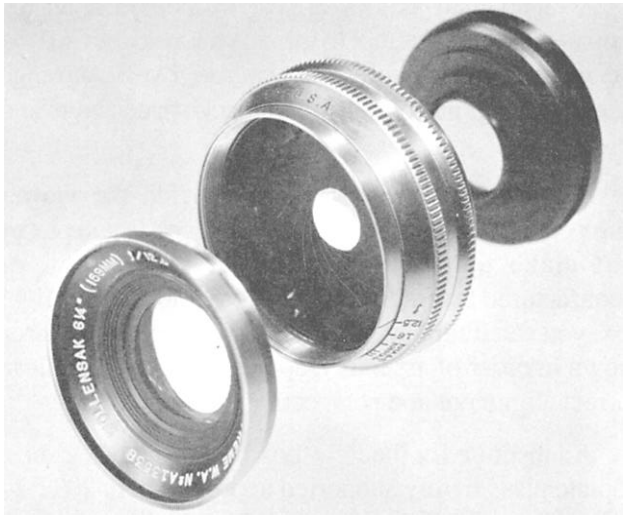
Another way to control reflections is to use a matte spray or dulling compound. Matte spray comes in a pressurized can and is useful for the high gloss of highlights on shiny, metal objects with curved surfaces. When used, the spray should be applied to the entire surface of the object. However, do not indiscriminately spray all types of surfaces. The spray may damage some finishes or plastics. When used on metal objects, it can easily be wiped off after the picture is made. Matte spray can also be applied to the back of a glass of clear liquid to cause the backlighting to spread more evenly over the back surface.

Cosmetic eyeliner, applied with a soft makeup or camel-hair brush, can also be used to help control reflections.



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Figure 6-13.–Using a mirror to show both front and back of the subject in one photograph.



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Figure 6-14.–Exploded views.

USING A MIRROR

It is often difficult to set up a camera for interior and closeup work to obtain the most desirable viewpoint. Space limitations or pieces of equipment may obstruct the view and make it impossible to photograph an assembly directly. Frequently, a mirror can be used to your advantage in product photography. A mirror placed at the proper angle and distance shows the opposite side of an object in the reflection, while the camera records the front side directly (fig. 6-13). For example, in photographing an object for damage assessment where the damage is on two or more surfaces, you may find it difficult or impossible to show all the damage in one view without the aid of a mirror. In such cases, the value of a picture may be greatly increased by showing all of the damage in one picture. One instance would be in photographing a cylinder that has been scored or cracked on the inside as well as damaged outside. Both surfaces may be shown in one view by using a mirror.

You may often find it desirable to obtain a picture of an object or part that shows its relation to the complete assembly. When it is impossible to position the camera and see the part or object directly, the problem may be solved by using a mirror to reflect the image of an assembled part.

Taking a picture of a reflected image presents some problems that are unique to mirror photography. It is difficult to prevent the mirror from reflecting other objects that are not wanted in the picture. You must be careful and place the mirror at the proper angle to eliminate unwanted reflections. When arranging the lights, avoid illuminating an object that produces undesirable reflections. Often a screen can be set up to block the reflection of unwanted objects.

Correct lighting of an object for mirror photography is slightly more difficult. Lighting on both the front and back sides of the object must be evenly balanced; otherwise, the mirrored image appears too dark or too light. Direct the light on the object from the mirror side as well as the camera side. When it is impossible to place a light on the mirror side of the object, use the mirror to reflect the light onto the back side of the object. This requires careful placement of the camera in relation to the light source to avoid strong rays of light from entering the lens. Spotlights are usually more suitable than floodlights as sources of illumination, because a beam of light is easier to control.

Focus the camera carefully when photographing a reflected image. Usually, it is necessary to use a small f/stop to increase the depth of field sufficiently. When focusing on a reflected image, the lens must be set for the distance from camera to mirror PLUS the distance from subject to mirror. This naturally requires a much greater depth of field than is ordinarily required.

EXPLODED VIEWS

Occasionally, exploded views (fig. 6-14) of small objects are photographed in a group to show the various parts of an assembly. Normally, they are arranged in the layout in the same order in which they are assembled or disassembled. Pay particular attention to the composition of objects as they appear on the ground

glass, rather than as they appear to the eye from the camera position. Attempt to arrange them so they fill the picture area in an interesting manner. Do not arrange them in a long, narrow line with black space above and below them.

Exploded view photographs provide the viewer with positive identification of the many parts and pieces that make: up a given machine, instrument, or manufactured assembly. When photographed on a light box, you can illuminate the shadows. The various parts, shown in order of assembly, appear to float in the air in correct alignment and perspective.

A substitute for the light-box background is a sheet of plate glass firmly supported approximately 20 or 24 inches from the floor. Two floodlights, directed from either side of the glass, bounce light evenly from the white seamless paper on the floor up through the glass.

Preparing the Parts

Disassemble the parts carefully so they can be laid out in order of assembly. Clean each piece thoroughly, removing any lubrication or foreign deposits. Lay the parts out as they are to be photographed, and study each piece before you proceed. Large areas of stainless steel or bright metal should be sprayed with a dulling spray to prevent objectionable "hot spots." Smaller areas can be treated with an eyeliner.

Where edges or screw holes do not show readily, they can be edged with a black grease pencil. Conversely, when the part is dark, white pencil or chalk can be used to define it.

Setting Up the Parts

Place the parts on the glass in order of assembly. To stand small parts up, mount them on a small strip or square of acetate with a little beeswax supporting the piece from behind. Even the smallest screw should be mounted on a base so it can be slid into exact position later. The base should be cut as small as possible so it does not interfere with other parts lined up close to it. Heavier pieces can be mounted on small squares of glass.

To obtain an illusion of height, you can move the parts away from the camera There is a limit to this procedure, however, and when a part becomes too small in relation to others, it should be elevated. Various size blocks (painted flat white) and, in some cases, glass shelves or long, narrow strips of glass are sometimes used.

Camera Angle

For the majority of subjects, the most desirable camera angle is 45 degrees above and to the side of the assembly. From this vantage point, you can see the top, side, and end of most parts.

PHOTOGRAPHING GLASS

In photographing glass, it is the background and reflections from the background that light the glass. Glass objects can be pictured clearly by lighting them in such a way that they stand out as dark outlined shapes against a light background or as a light outlined shape against a medium or dark background. These techniques of lighting are actually variations of a basic silhouette method.

The Set

The setup for photographing glass products consists of white seamless background paper. The background paper is curved forward on the floor so it is completely underneath the area containing the setup. Place two supports, such as sawhorses or tables, on the forward part of the background paper. The supports should be spaced to hold a sheet of plate glass. The plate of glass gives you a transparent worktable through which light bounced off the background paper in back of and underneath the glass product will pass. Strips of colored or black paper can be attached, out of camera view, to the background paper for edge effects to the glass products.

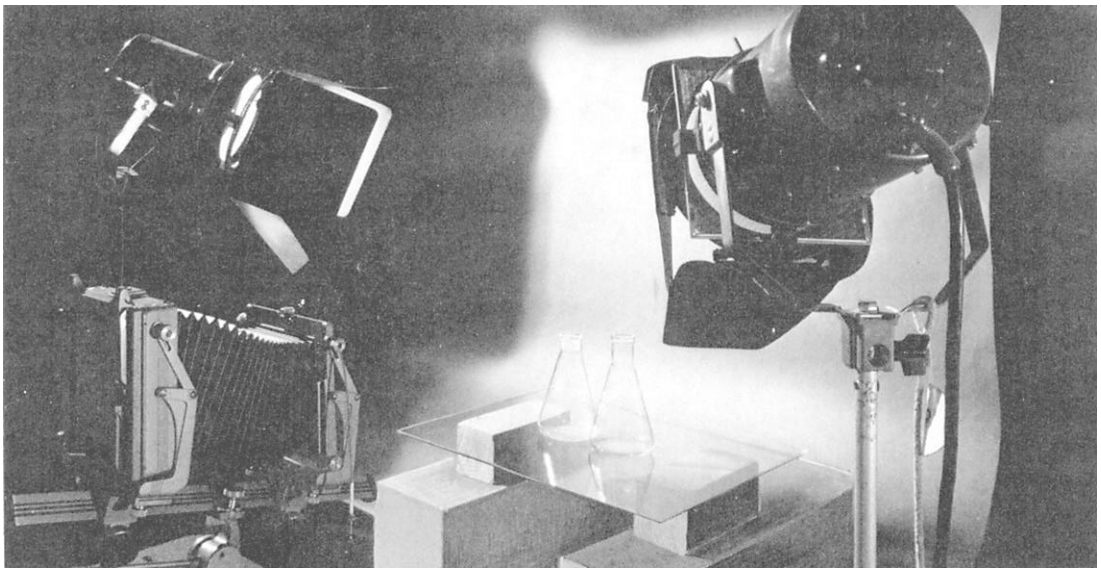
Because the light reflected from the background is usually the only source of illumination, the film exposure is relatively long. Proper camera equipment and a sturdy tripod are necessary to prevent movement during the rather long exposure.

The height or camera angle varies for different subjects and showing the ellipse or oval of the rim adds depth and roundness to the picture, since most glass items you photograph are three-dimensional.

Lighting

You should be able to darken the studio completely. An overhead light, an exit sign, or even a light leak around a door can cause problem reflections. And not eliminating unwanted reflections results in much time and effort wasted.

Lighting glass products (fig. 6-15) is mostly a matter of personal taste. It can be learned by practice and by



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Figure 6-15.–A typical setup for lighting glassware.

studying photographs of glass items. When you are studying pictures of glass objects, notice how all the good pictures were made using variations of basic silhouette lighting. You will find it is easy to produce an infinite variety of effects by simply changing or redirecting the bounce light from the background.

In photographing glass there are no hard-and-fast rules for the placement of lights. The lights should, however, be placed with great care. Changing the angle just a little can drastically change the lighting effect and at the same time cause flare problems. When the lights are positioned to cause a great deal of reflection from the background and this reflection is uncontrolled, it may cause lens flare and result in flat negatives. Lens flare can be controlled or eliminated by erecting a black tent to extend from the lens board to the subject. This tent must be kept outside the angle of view of the camera. A focusing cloth draped over wood dowels works well. When photographing glass products, you should always use a matte box over the camera lens.

When the lighting produces a true silhouette, some highlights (fig. 6-16) may be desired to add sparkle to the glass. This can be done by using front bounce light from a narrow, diffused light source. To create such a source, attach a piece of white mounting board to one barn door of a floodlight and control the width of the light beam emitted with the opposite barn door. This narrow beam of light can be placed on either side of the camera and should be at camera level or higher. The spacing between highlights on a cylindrical object, created by this method, can be controlled by moving the light closer to or farther from the lens axis. Do not allow highlights to obscure etching on the glass.

Exposure

To determine the exposure for photography of glass objects, you should take a normal reflected exposure meter reading of the background and increase the indicated exposure by four times.

Black-and-white film should be given a shorter than average developing time because the lighting ratio is usually very great, and excessive contrast will result with normal development.

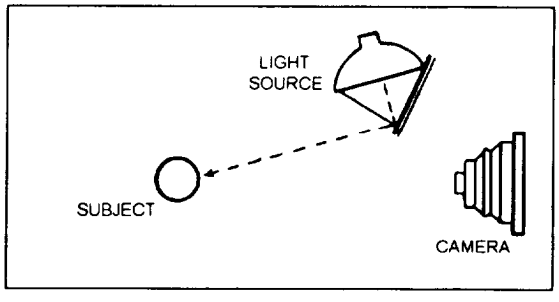
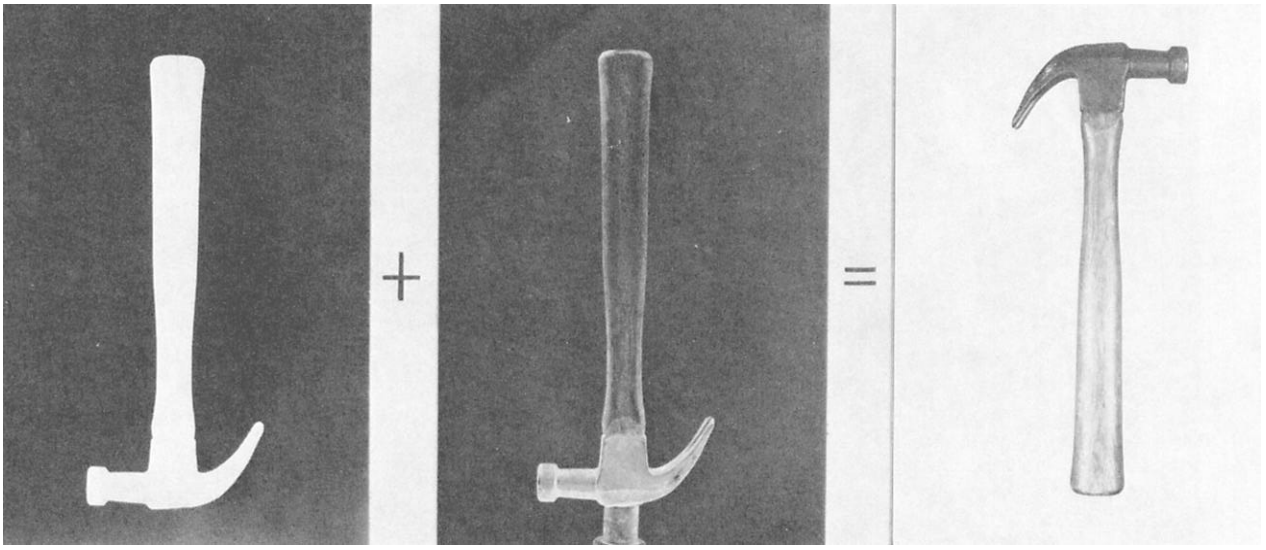


Figure 6-16.–Adding highlights to glass products.



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Figure 6-17–Sandwiching two negatives to eliminate the background.

BLOCKING OUT A BACKGROUND

It is a simple matter to eliminate or block out an unwanted background in product photography. The technique involves two negatives. Two separate pictures are made of the product setup. One exposure on continuous-tone film is made of the product lighted normally. A second exposure, on high contrast line-copy film, is made of the object silhouetted against a well-lit white background. The two negatives are then sandwiched together and printed.

The setup for this procedure is much the same as for a straight product picture. The lighting, however, is a little different. Figure 6-17 shows a typical setup for this two negative technique. The procedure is as follows:

1. Support the product so it cannot move between the two exposures. Use a small support because it must be opaqued out of your line copy or background negative. A light table may make a good support, but when some other support is used, keep it far enough from the background so the background can be lighted separately.

2. Light the product to provide maximum detail. Do not worry about objectional shadows on the background or visually separating the product from the background. In fact, with this technique, lighting that separates the subject from the background may cause a loss of detail at the edges of the subject.

3. Use a white paper background that is large enough to fill the camera view. The background illumination must be very even because the high-contrast film used to make the background negative has a short exposure latitude.

4. Use continuous-tone film to make the subject negative. Use Kodalith Ortho film to make the background negative.

5. It does not matter what exposure you make first. However, each exposure must be treated separately. Only the lights for the exposure being made should be turned on.

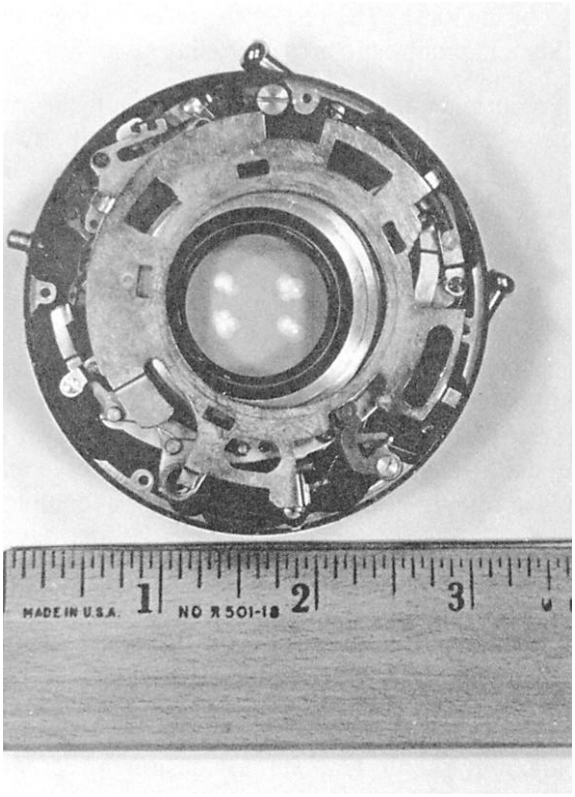
6. Because lenses can shift focus at various f/stops, the same f/stop must be used for both exposures and the camera must be rock steady-it cannot move between exposures.

7. Load one film holder-one side with continuous-tone film and one side with high-contrast film.

8. Make the exposures. When you are making the background exposure, be certain there are no specular reflections bouncing off the background onto the subject, and use only the background lights. When making the subject exposure, use only the subject lights.

9. Process continuous-tone film and line-copy film as recommended in the *Photo-Lab Index.*

When you include a ruler (fig. 6-18) in the scene in product photography, especially for damage reports or forensic purposes, it indicates exact scale and simplifies printing the photograph to exact size.



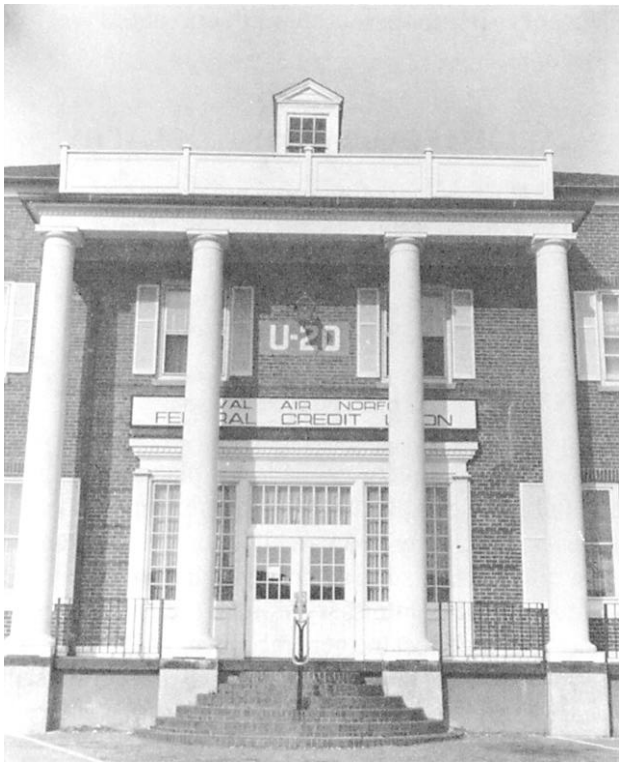
PH3 Yvonne Albritton
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Figure 6-18.–Ruler included in product photograph.

CORRECTIVE PHOTOGRAPHY

Corrective photography is the correct representation of three-dimensional objects on a single plane (the photograph).

At one time or another, you have probably taken a picture with the camera tilted up or at an angle to the subject, and you probably learned by experience what the resulting distortion did to an otherwise good picture. Most of the cameras you use on location do not have movements or adjustments for correcting vertical or horizontal distortion that is created when the camera is tilted or used at an angle to the subject. Such inflexible cameras do not allow you to present the subject correctly from any camera position that shows two or three sides of the subject. For the correct presentation of such subjects, camera movements must be used. Many students of photography, as well as many **self-acclaimed** pros, are inclined to use cameras lacking the essential advantages (camera movements and adjustments) of a view camera. Instead they use their "regular" camera for every assignment even when a view camera is the **only** correct camera for the job. Refer to chapter 4 to re-familiarize yourself with the view camera. Figure 6-19A and figure 6-19B show the



PHAN M. Lakner
302.138A

Figure 6-19A.–Uncorrected vertical distortion.



PHAN M. Lakner
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Figure 6-19B.–Correected vertical distortion.

difference in uncorrected and corrected vertical distortion.

ARCHITECTURAL PHOTOGRAPHY

Architectural photography are pictures of man-made structures, especially buildings. These pictures may be made for planning, construction progress, illustrative purposes, inspection and survey, and other similar purposes.

PLANNING PHOTOGRAPHY

Architectural pictures made for planning purposes may fall into several categories. For example, the civil engineer working with an architect on design plans for a new commissary store at the naval air station may need a picture of the commissary store at the naval shipyard to show the architect the general concept of how the new store is to look The engineer may also need the same picture plus pictures of other buildings near the proposed construction site to be included in the contract bids. These planning pictures may have to show obstructions to heavy equipment, or where the new store will be located in relation to other buildings, proposed and existing. The architectural pictures you make may be presented to the U.S. Congress for allocation of new-construction funds.

CONSTRUCTION PHOTOGRAPHY

Construction progress architectural pictures, (fig. 6-20A and fig. 6-20B) or simply construction progress pictures, are used as proof of construction progress from architect-to-builder-to-Navy. Whenever buildings or facilities are being built, a photographic record of the project should be made. These pictures may show whether the contractor did or did not follow specifications as written in the contract. They can also serve as a visual record of the material used in construction. In addition to their normal preservation as part of the construction contract record, they form the basis for periodic reports to higher echelons, including Congressional Armed Services Committees. Some of these pictures may be of great historical value, but their most important function is to serve as documentation for construction work

For a complete record, pictures must be taken at intervals throughout the construction period. Excavation, foundation work, and the roughing-in process progress slowly; pictures made every 7 to 14 days, starting at day one, may be adequate to show this phase of the work. The rest of the work may go more quickly and require pictures every day or so.

For an accurate record of construction, the pictures are usually made from the same camera position from day to day. However, as construction progresses, it may be necessary to make additional views, both exterior and interior.

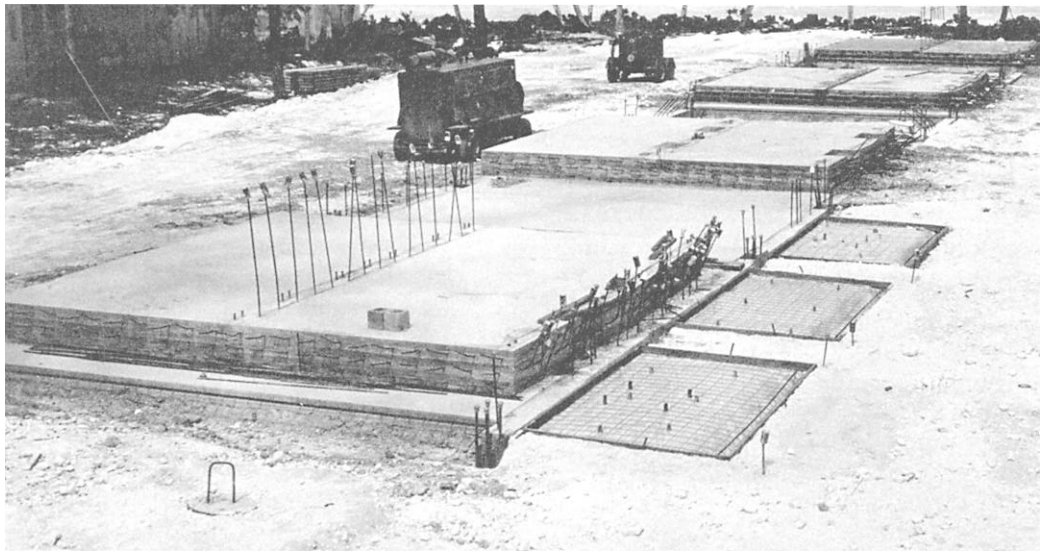
The person for whom you are doing the photography should explain any special effect desired in the pictures; for example, accenting structural texture, highlighting a specific construction detail, pinpointing an architectural feature, or concentrating on an exceptional landscape view. And do not forget to make the last picture-the one that shows the completed project. We do not mean the one made the day the contractor removed his last hammer from the jobsite. Of course, you made that picture. We mean take a picture several months after the project is "finished," when the grass is green and the trees are planted.

The same care you give to other types of photography should be given to construction progress photography. Do use good composition and lighting techniques and other similar applications of professional photographic skill. Take particular care with shadow areas that may contain important details.

ILLUSTRATIVE PHOTOGRAPHY

The uses of illustrative architectural pictures in the Navy vary greatly. The commanding officer may want pictures that concentrate on overall design to show at a meeting with the admiral. The civil engineer may want pictures that show functional aspects of a building to be included in a report, and the operations officer may want a picture of the operations building, crash and rescue fire house, and the control tower to decorate his office. The editor of the station paper may need pictures that show a building before and after a self-help project. And, of course, the publisher of *Welcome Aboard* wants a picture of the BEQ and the mess hall. All these pictures are considered illustrative architectural photography and should be made to show the buildings to best advantage.

This type of photography is best done with a view camera so horizontal and vertical distortion can be overcome as much as possible. When making this type of picture, be sure there are no distracting elements in the picture area. The foreground and background should be clean. When possible, have all the windows and doors the same; for example, the windows should all be open or closed and the same for doors. When the windows



133.499

Figure 6-20A.–Construction in progress.



133.500

Figure 6-20B.–Construction in progress.

have shades or blinds, they should also all be in the same position.

INSPECTION AND SURVEY PHOTOGRAPHY

As with the other types of architectural photography-buildings or facilities-inspection and survey pictures play an important role in the Navy. The Naval Investigative Service (NIS) may need pictures of a building to point out weaknesses in physical security. The fire department uses pictures of the station theater to train the fire fighters in evacuation measures. And the safety officer certainly needs good pictures to show the extent of damage or existing hazardous conditions to buildings or personnel.

Exterior Photography

Buildings must be photographed pretty much as they exist. With portraits, for example, you can ask the sitter to smile and pose, and with still life you can alter the arrangement. You cannot do either of these with a building. The main controls you have over the picture are the viewpoint and the lighting.

For exterior architectural pictures, the position of the sun in relation to the subject is a very important consideration. Which sides of the building are lighted and at what time of day? Where are the shadows cast?

Architecture is dead without light. Like the sculptor, the architect shapes forms in relation to lighting. The lighting at a site is often studied long before the first plans take shape on the drawing board. The lighting becomes a deciding factor in determining the character of a building, the choice of materials, and the location of the building.

The nature and direction of the light are the two main components of our concept of lighting. "Normal lighting" is often preferable for perfect reproduction of materials; that is, light from a slightly overcast sky. This diffused light reduces contrast in the texture of the material just enough to create a good balance between the highlights and shadows. A building as a whole is often depicted better in direct, angled sunlight from a cloudless sky. Filters are used to control the contrast between subject and sky. Direct sunlight often produces contrasty pictures with simplified lines that may sometimes be preferable as an illustrative effect. The light in cloudy weather is the worst kind of lighting for architectural photography. Try to avoid making pictures of a building in cloudy weather. The direction of the light on sunny or slightly overcast days governs the form of the building and the ability of the photograph to bring out its characteristic features. Since the position of the sun in relation to the building constantly changes, there is only one way to determine the best lighting-study the building at different times of the day. Only then is it really possible to identify the best lighting for the building. Moreover, you should be prepared to study the lighting from different angles. Do not be content with your first camera angle. You should always check to see whether there is a better angle.

A building should be depicted so the viewer experiences its volume and materials. This is often impossible, except with side lighting. The greater the angle of the light, the greater its ability to produce a forceful re-creation of materials and shapes (fig. 6-21).

Also to be considered are the surroundings. Is there construction going on in the background? Is there a distracting landscape or unrelated building that must be concealed? What is the best camera position for making this particular picture ? Can I get far enough away to present an undistorted image? Should I have a ladder to stand on or can I make this picture from on top of another building or must I arrange with public works for a bucket truck? What number of viewpoints are required? What focal-length lens is best for each view?

Viewpoint

The greatest difficulties in photographing buildings is converging verticals. When you hold the camera so it is pointing horizontally, you often find there is too much uninteresting foreground included in the picture, and you may be "chopping" the top of the building off. So, tip the camera back to eliminate most of that foreground and get the top of the building back into the picture. Now, look what has happened-the vertical lines are converging; they are no longer parallel; they are sloping in at the top of the picture. The picture is distorted. A good architectural photographer does not produce such a picture. Instead, he uses a view camera and does it properly.

Interior Photography

Photographs of interiors can be grouped under three headings:

- Public interiors of all kinds, such as assembly halls, places of worship, libraries, galleries, auditoriums, and theaters
- Residential interiors, both large and small



PHAN Wright
302.141

Figure 6-21.–Exterior architectural photograph shot with 45-degree lighting.

- Details of interiors, mainly close-ups of adornments, technical features, interior decorations, and so forth.

Photographs of public interiors are often characterized by size, dominance, scale, and measurements. You must be careful of fluorescent lights when shooting color film. They can produce color casts. If the fluorescent tubes are all of the same type, the color cast can be corrected with filters. Fluorescent lighting is, however, often excellent for black-and-white photography. In interior photography of public buildings, an attempt may be made to shoot from a somewhat higher camera angle than eye level to provide an overview of the scene. It is important not to have the first detail in the subject too far from the lower edge of the picture. The interior should glide into the image frame in a natural way. Maximum depth of field is the only acceptable technique here.

Another important problem in public and residential interiors is the balance between natural outdoor light and indoor artificial light. When lighting is mixed this way, it is better to delay shooting until the daylight is too weak to overwhelm the interior lighting. Using the light of the midday sun is definitely wrong. It is also wrong to photograph interiors so late in the day that the sky seen through windows is completely black So a time near sunset or, if you wish to avoid visitors, the early morning hours is recommended, especially for color photography. Measurement of the ambient interior illumination and the outdoor light gives you a good idea of the best time to take pictures. Lenses with built-in leaf shutters are major assets in interior photography when some daylight is present, because they synchronize with electronic flash at all speeds. The choice of a suitable shutter speed allows you to obtain balance between daylight and flash illumination.

INDUSTRIAL PHOTOGRAPHY

Photography is regarded as indispensable to Navy industry. You say you did not know the Navy was or had industry? Well, stop and think for a minute. How about the naval aviation depots, the public works centers, and the shipyards? The demands for good photography for research, development, documentation, and communication placed on us by these industrial types of

activities has made photography an integral part of the Navy's industrial framework.

You should be able to tackle just about any photo job that comes up. When shooting industrial photography, you must work closely with research and development engineers, machinists, and technicians far outside the realm of photography. You must be the master of photographic techniques, and have an eye for good pictures-plus imagination for creative photography.

Know Your Subject

Before a satisfactory photographic record of an industrial situation can be produced, you must have an adequate understanding of the subject. For instance, when you are called on to photograph a malfunctioning machine that is capable of performing several operations in the manufacture of an aircraft wing component, you should be told-better yet-shown, how the machine, or one like it, works. With this information, you are better able to shoot the malfunctioning machine and show what the problem is or what is causing the problem. Granted, you could probably make the picture if someone just pointed you in the right direction. It is not always possible to discuss each intimate detail of a problem, but it is certainly possible to make clear just what a photograph should illustrate. This kind of preparation is possible only when there is cooperation between the photographer and the requester. Coordination of photographic activities within an industrial organization promotes a better understanding between everyone concerned, and it leads to a more effective application of photography.

Safety Precautions

Photographers, like other people in and around industrial operations, must observe existing safety precautions. If your imaging facility does much industrial photography, it should have, as a minimum, a safety helmet and protective clothing available for you to wear.

An industrial photographer, like other photographers, must be able to move around to determine the best camera angle. You must also keep in touch with the people responsible for safety to avoid risks to yourself and others. The people in the photographs must also be shown wearing their safety helmets, hearing protectors, and so forth.

The camera also must be protected. It is a precision instrument and should be given adequate care and protection. When in use, the camera usually does not need any more protection than the photographer. But it should be given extra protection when used in places exposed to flying sparks, spattering molten metal, and so forth. A skylight filter on the lens should always be used to help protect the lens. This filter does not affect exposure or color balance but does protect the lens element. Buying a new filter is a lot cheaper than buying a new lens.

A lens shade should be the constant companion of every lens. It keeps a lot of extraneous light from entering the lens and can also protect the lens from certain types of damage.

Photographing Large Machines and Equipment

The photography of large machines or equipment, such as hydraulic presses and aircraft during rework or ships during construction or overhaul, presents special problems. The bigger the equipment or unit, the more difficult it is to photograph.

In many instances, the equipment may be part of the industrial production setup and the picture making must be planned so it does not interfere with production.

Pictures may be needed at various stages of work to show wiring, piping, and components that are concealed during later steps of production. Pictures are able to show the location and methods of production and assembly. These pictures are often used to highlight certain aspects of work equipment failures, repairs, and modifications.

The Right Viewpoint

When you photograph large equipment or machines (fig. 6-22). a series of pictures is one of the best ways to cover the assignment. The larger and more complex the subject, the greater the need for a series of pictures. The series of pictures should be planned to record important details of the subject. The views to be considered are as follows:

- Plane views-show detail in various components and parts of the equipment

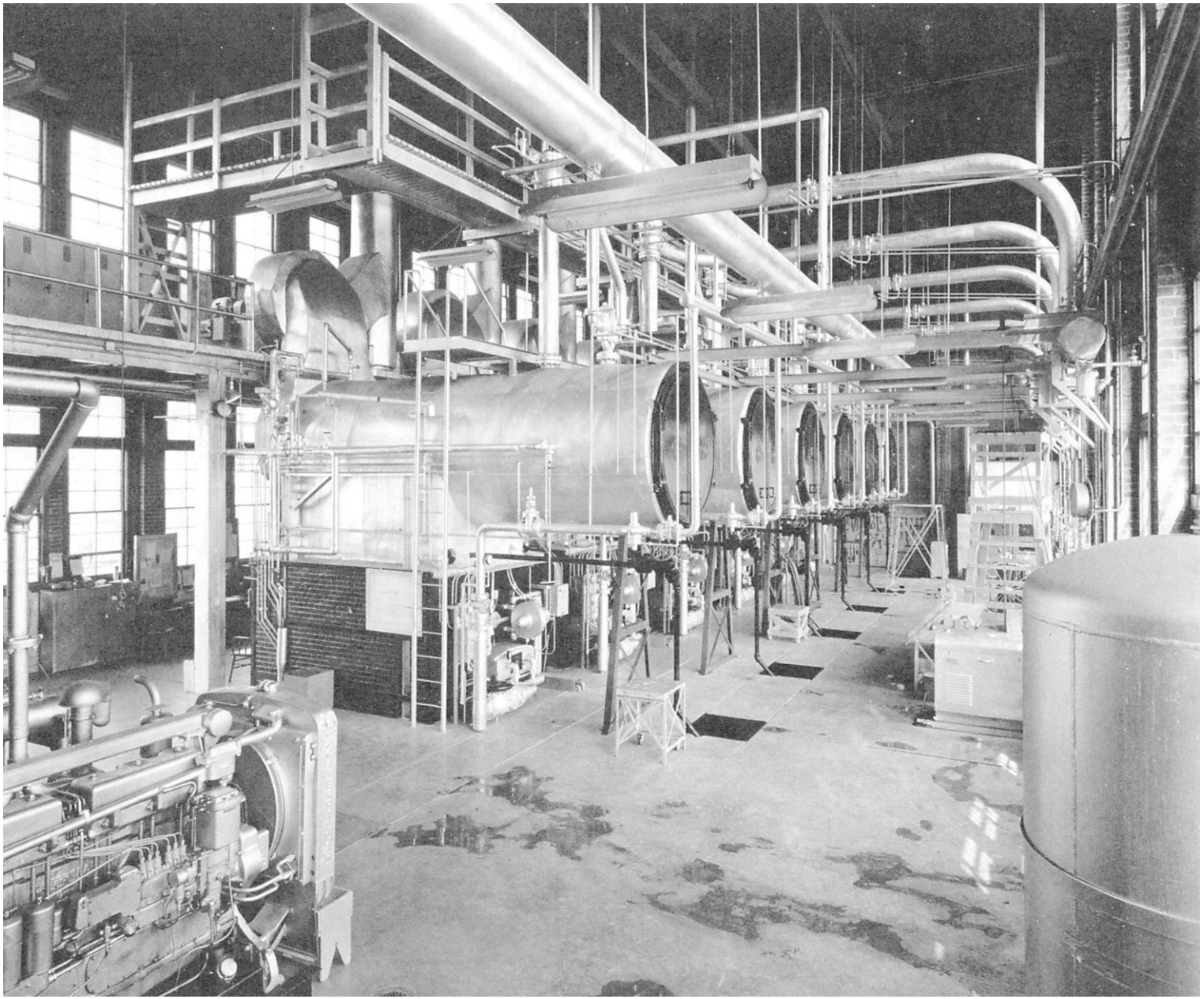
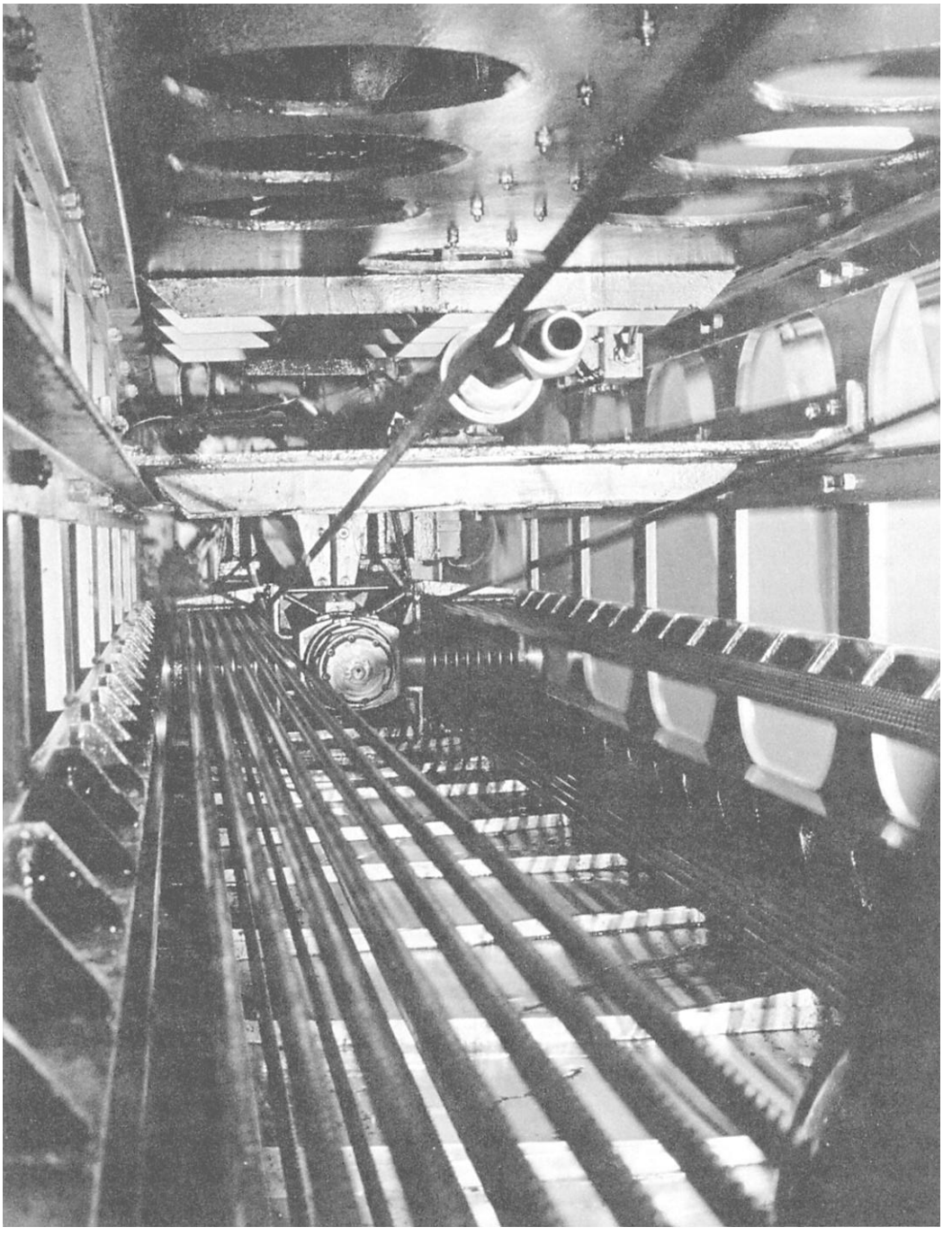


Figure 6-22.–Interior view showing machinery installation. **237.220**



JOCS R.P. Benjamin
302.282

Figure 6-23.–Catapult retraction system.

- Relationship views-show the relationship or association of various parts and components, one to another (fig. 6-23)

- Complete views-show the equipment from different angles

The plane view is made of an entire unit or, if the unit is very large, segments of the unit. Plane views are also made of sections of large units to show greater detail. Along with the plane views, three-quarter views may be needed to show the relationship of unit parts that do not appear in the plane views. Complete overall views of the subject are often made from a high viewpoint. An oblique view from a high vantage point often shows the three-dimensional relationship between equipment parts.



302.283

Figure 6-24.–A starboard-bow view of the Soviet-guided missile cruiser *Slava.*

INTELLIGENCE PHOTOGRAPHY

The purpose of intelligence or reconnaissance photography is to gain information about an enemy or potential enemy. Now that the Soviet Union has been disestablished, the Russian threat to our national security has been greatly reduced. This does not suggest that intelligence photography is no longer required, but that our focus on other threats has intensified. Whether it be interdiction of drug smuggling operations from South or Central America or the potential nuclear threat of a third world nation, the need for intelligence photography will always exist.

Many people think intelligence photographs are always taken with highly sophisticated equipment from an aerial or satellite platform. While it is true that a great portion of intelligence is gathered through these means, much information can be gathered at ground or sea level. In this training manual, aerial collection of information is not addressed. However, intelligence photography from ships or shore, specifically the photography of ships, aircraft, and ports is discussed (fig. 6-24).

When you are shooting photographs for intelligence purposes, high-quality and sharp image definition is of utmost importance. Black-and-white film is primarily used for intelligence photography due to its finer grain and higher resolution than color film. Whenever possible, black-and-white and color film, as well as motion video, should be used to document subjects of interest for intelligence purposes. The best black-and-white film for this purpose is Kodak Technical Pan (Tech Pan 2415), because of its ultra-fine grain and extremely high resolving power. For color intelligence photographs, you should use Kodak Ektar films, because of their fine grain, higher sharpness, and the variety of speeds available (IS0 25, 125, 1000); they also have the ability to produce high-quality enlargements. Although the resolution of video is inferior to that of film, the ability to view video instantly is advantageous for subjects of special interest.

SHIPS

When assigned to provide photographic coverage of a ship for intelligence collection purposes, you should attempt to provide as much information about the subject as possible. The standard nine-point coverage assists in providing this information in a photograph. The standard-nine points are as follows:

1. Bow
2. Starboard bow
3. Starboard beam
4. Starboard quarter
5. Stem
6. Port quarter
7. Port beam
8. Port bow
9. Vertical

The two most important shots are the starboard beam and the port beam. These two angles are most helpful to analysts for determining the overall dimensions of the ship.

High-angle photographs, such as from a crane, tower, or superstructure, are desired whenever possible. Closeup photographs taken with telephoto lenses are also important to support the basic nine-point coverage. You should photograph the following items (in priority order):

1. Over-the-side equipment and buoys
2. Missiles and launchers
3. Radars
4. Antennas
5. Sonar domes
6. Sensor protrudents
7. Helicopters (on deck and in flight)
8. Unusual optical or electro-optical devices
9. Unusual activity
10. Guns
11. Superstructure
12. Cranes, masts, and booms
13. Ports, hatches, and openings
14. Appendages and fittings
15. Identification numbers, flags, and markings
16. Oceanographic deck equipment

It is good practice to overlap your coverage when shooting with a telephoto lens. This will aid in determining the working relationships between components as well as providing the largest image possible on the negative or videotape. Photographs that provide information pertaining to cargo, personnel count, and bridge or electronic detail may be invaluable. It is better to overshoot than not to cover an area that may provide critical information about the subject.

More times than not, the lighting conditions are very poor when shooting photographs for intelligence purposes. Remember, the exposure latitude for Tech Pan film is very short, so your camera exposure is critical. You will be shooting into shadow areas and open hatches, so bracket all your frames to ensure you record detail.

When a submarine is the target of special interest, closeup views of the following equipment is useful for intelligence gathering:

1. Armament installations
2. Electronic installations
3. Sail area
4. Telescoping equipment
5. Unusual sensor probes and devices, such as trailing wires
6. Unusual, unidentified, or modified equipment

If you are photographing equipment, cargo, or written material that is recovered from floating wreckage of a ship, you should include a ruler in the photograph to show a scale as to the size of the object. The use of a macro lens will be needed to photograph nameplate data, writing, or markings on the recovered material.

AIRCRAFT

Photographs can provide valuable information about the capabilities, mission, and useful range of an aircraft. Whether the aircraft is in the air or on the ground, the way you photograph it aids the analysts in



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Figure 6-25.–The Soviet cargo ship *Nbah Pycakob* in the port of Conakry, Guinea.

determining these factors. The basic requirements for photographic coverage are as follows:

1. Overlapping views of the port side, the starboard side, and the underside, including wings and wing tips
2. Radome and appendages
3. Antennas
4. Fuselage area under the horizontal stabilizers
5. Upper section fuselage
6. Odd-colored covering on the skin of the aircraft
7. Bomb bay areas, especially if open
8. Other open hatches
9. Landing gear
10. Engines and cockpit
11. Identification markings
12. Weapons

When shooting aircraft, the underside of the aircraft is almost always in shadow. Remember to compensate for your light meter reading, particularly when the aircraft is airborne. Use the substitution method of exposure to record an acceptable exposure.

PORT

There are times when the ship may pull into a port that has not been visited by Americans for quite some time (fig. 6-25). Photographs can provide a wealth of information such as trading, harbor depth, and various other activities and capabilities of a port. You may be tasked to provide photographic coverage. The following areas should be documented:

1. Panorama of port
2. Ships in port
3. Channel markers

4. Piers
5. Cranes
6. Warehouses
7. Railheads
8. Fuel farms
9. Port headquarters building
10. Dry docks
11. Ship repair or ship building yards

Most photographs of a port can be taken when your ship is entering or leaving the harbor. Never sneak around military installations or restricted areas in any port.

CHAPTER 7

PORTRAITURE

A portrait is a likeness of a person, especially the face. This definition isolates *one* essential point in portraiture. A portrait should emphasize the person, rather than the person's environment or something associated with the person. However, a pictorial representation that portrays *only* a recognizable likeness of a person is not enough. A portrait must be more than just a photograph, It must have mood, personality, and possess characteristics from which a viewer can draw conclusions about the subject. By manipulating expressions, posing, lighting, and environments, a portrait photographer can portray any mood from happiness to gloom, as well as the personality of a subject. Posing the subject with familiar objects and environments can produce a more natural expression and pose because the subject will be more at ease. Articles or props included in the scene can help tell more about the subject.

Success in portraiture requires a thorough understanding of the techniques involved, an artistic ability, and a talent for directing the subject through a desired expression or pose. The portrait photographer should have a sensitivity for, and an understanding of, people. Portrait photographers vary considerably in their styles and techniques. The subjects of portraits vary in their likes and dislikes. There is no one blueprint or formula that will assure success.

The portrait is an interesting and challenging assignment to many Navy photographers. In portraiture the subject is always changing and challenging the Photographer’s Mates. To meet the challenge of portrait photography, you must have vision, good judgment, and the ability and willingness to show them to greatest advantage.

Most people have their portrait made because they want someone else to see how they look A beautiful woman knows she is beautiful, and in a picture, she wants to appear beautiful-so make her beautiful. Some flattery may be necessary, but you should not overdo it. Men know their features; they know whether they appear dignified; they know whether they appear to have great strength of character; and they are correct in expecting the photographer to emphasize these good points. The subject expects a true portrait-a good expression and a natural pose, a portrait that shows whatever beauty or strength the person has, and one that reflects his or her character and features.

Character is formed by life. A frown or a smile today leaves no trace, but continued use of facial muscles to form a smile, a laugh, or a frown leaves lines on the forehead, around the eyes, nose, and mouth. These lines and expressions form facial character. They are subdued or exaggerated by the way you light the subject. You should not eliminate character lines altogether, but, you should only soften them with lighting. A face has features: two eyes, a nose, a mouth, and two ears, but photographically these features are not equally important. To the portrait photographer, the most important and most expressive are the eyes; the mouth is second only to the eyes.

Facial expressions constantly change and last only momentarily. No happy expression or frown lasts long enough to take full notice of it-until it is photographed. When you photograph an expression at the wrong instant, all the bad points appear exaggerated.

To be a good portrait photographer, you must learn to study each face as it appears before the camera, and light it to represent the natural features and character accurately. Do not try to capture that fleeting expression. It is not the expression that shows that person's true character. What you want is a person's natural expression. A softness of expression is best-neither too sharp nor too faint; not too lively or too gloomy.

PORTRAIT STUDIO

The portrait studio should be a place isolated from distraction where the photographer and subject can work without interruption. It should be a comfortable place where the subject feels at ease, where the *tested* equipment works, where the color quality of the light can be controlled, and where the photographer and subject can move from pose to pose without interruption. Avoid using the portrait studio as a crew's lounge or lunchroom. The portrait studio should always be clean and neat. The portrait studio is one of the few areas that customers ever see, and it represents the overall condition of your photo lab.

The studio should be arranged so the lights, camera, and electrical cords are safely out of the way and your subject does not have to avoid tripping over them. Every effort must be made to make the portrait session a pleasant experience for the customer. Any props to be used should be stored out of the way where they can be retrieved quickly and easily.

The studio should be spacious enough to move around freely, with enough room surrounding the posing bench so the subject does not feel crowded. The distance from the posing bench to the background should be great enough so shadows from the subject are not cast onto the background. This distance should also be great enough so the background is out of focus when the lens is stopped down to the working aperture. The studio should have enough room so a longer than normal lens can be used and provide enough room behind the camera so the photographer can move about freely. It should be wide enough so the lights can be moved in an arc around the subject without changing the light-to-subject distance. The ceiling should be high enough to provide enough space for a standing full-length portrait.

Whatever the size or location of the studio, it must, above all, be a productive, professional workplace, having everything required to produce technically perfect portraits.

In many Navy photo labs, especially the old ones and aboard ship, these conditions do not exist. Just because you do not have a large “professional” studio and equipment does not mean you cannot produce professional quality portraits. Many professional quality portraits are made by Navy Photographer's Mates using only two small lights in a compartment being used as an office, finishing room, and darkroom aboard ship.

STUDIO EQUIPMENT

There are endless types and manufacturers of studio equipment available for controlling light and making portraits. The size and the budget of your imaging facility determines what is available for making portraits. This chapter discusses only the basic studio equipment that is common to most Navy imaging facilities.

Camera

Regardless of what camera you use in the portrait studio, it should be clean and in good working order. The camera should have interchangeable lenses and be at least medium format. The larger the negative size of your portraits, the higher the quality of the finished product.

Lenses

A lens used for portraits should have a longer than normal focal length. A long-focal-length lens produces a large image on the film while keeping the camera at a far enough distance from the subject to prevent image distortion. Normal-focal-length lenses are too short for anything but full-length portrait photography. They require the camera to be too close to the subject, image distortion becomes apparent, and working too close to the subject may intimidate him or her. Working too far from the subject with a normal lens to prevent distortion makes the image size too small. The ideal lens for portraiture should have a focal length equal to 1 1/2 or 2 times the diagonal of the film. When you are using 4x5 film, the lens focal length should be about 8 to 12 inches.

Background

Simplicity is the key word in portrait backgrounds. Simple backgrounds give more artistic results by maintaining viewer interest on the subject. The most widely accepted background is a large, flat, unmarked surface, such as a painted screen, an actual wall of the studio, or seamless background paper suspended from the ceiling. Whatever the background, it should have a matte finish, rather than a glossy finish. A glossy finish causes distracting reflections.

A background can be plain or patterned. When the background has a pattern, it must not detract the viewer from the main subject. When props are used, such as a globe or an American or Navy flag, they must not draw attention away from the subject.

The background should normally be light and neutral in color; however, black or dark backgrounds are used for certain effects. A black background is used to add richness to the finished print. When a black background is used, keep your subject a good distance from it to prevent the lights (except the background light) from striking it.

The color of a background becomes important when color portraits are made. Bright-colored backgrounds should be avoided because they distract from the subject. When using a cold-colored (blue, green, etc.)

background, you must prevent the background from reflecting colored light onto the sides of the subject's face. This produces a sickly appearance. The background tone can be changed by adjusting the amount of light falling upon it. Dark backgrounds with earthen colors, such as brown and dark orange, can be used for low-key portraits. Intensely illuminated backgrounds with light pastel colors can be used for high-key portraits.

Your studio should have enough backgrounds to meet the demands of customers. As a minimum, you should have a gray or light blue background for roster photographs and white for full-length photographs. Always stock extra white seamless paper. White seamless paper is used mostly for full-length photographs. This paper becomes dirty and is torn rapidly since it is being continually walked on. You can extend the life of the background paper for full-length portraits by laying sheets of acetate (such as clean-up film) on top of the area to be walked on. The acetate does not show up on the film or print.

Lights and Accessories

Almost any type of light can be used for portrait photography. This includes natural light, such as the sun, as well as artificial light, such as electronic flash.

The sun, with its different forms of illumination-daylight, skylight, and window light-is the major source of natural illumination for portraits. The sun is used primarily for location portraiture.

Most types of artificial light can be used for portrait photography as long as the intensity is sufficient to permit short exposures. Short exposures are desired because it is difficult to keep a subject motionless during a long exposure. For color portraits, the color quality of the light source should be the same as that for which the film is balanced. Of all the artificial light sources available, electronic flash is the best light source for portrait photography because of the following:

- It provides a large output of light without the annoying heat produced by incandescent lights.
- The extremely short duration of the flash stops subject movement.
- The color temperature of the light is compatible with daylight.
- They are as versatile as other light sources.

Electronic flash units specifically designed for portraiture usually have tungsten modeling lamps located near the electronic flashtube. These modeling lamps provide constant, low-intensity illumination on the subject or background. This allows you to see the lighting effect that will be produced when the electronic flash units are fired.

BASIC LIGHTING UNITS.–Studio electronic flash units are divided into two broad classifications: those that project a relatively narrow cone of concentrated, crisp light and those that project a broad area of softer, more diffuse light.

Spotlight.–A spotlight projects a narrow, highly concentrated, crisp beam of light, produced by an undiffused clear flashtube. A Fresnel lens or a small reflector with a mirror finish is used to direct and focus the light. The light produced by a spotlight is very much like direct sunlight on a clear day. The light rays are nearly parallel and are not diffused. The shadows cast by a spotlight are hard with sharply defined edges that add crispness. A spotlight is usually used to highlight or stress a feature of the subject or as a hair light or background light.

Floodlight.–A floodlight produces a broad area of partially diffused, soft light, very much like sunlight on an overcast day. A frosted globe is used over the flashtube, so the light produced is initially diffused. The light is further diffused by the reflector that causes the light rays to cross and interfere with each other. The rays, projected from the front of the flashtube, however, are not as diffused and have a crisper quality. The light, produced by an electronic flash floodlight, has a crisp quality at the center and a softer quality toward the edge. When you want to use just the softer part of the light, allow only the outer part of the light beam to fall on the subject. This technique is called *feathering* the light. When you want the entire beam of light to be diffused and very soft, use a diffusing screen over the light source. There is also a type of light unit known as a *capped* light. This type of unit has an opaque metal cap placed in front of the flashtube to block specular light from reaching the subject. All light projected by a capped unit is diffused.

A floodlight is usually used as the main (modeling, or key) light in portraits, especially where a soft effect is desired. It is also used as a fill light because a fill light is always diffused.

ACCESSORIES.–Many accessories are available for use with studio lighting units. Accessories are

important tools that make your portrait lighting units either more dependable or more versatile. They aid in creating the exact lighting affect you want. Common accessories are as follows: diffusers, barn doors, snoots, and umbrellas. If accessories are not available, compromises in the lighting can alter the effect and quality you desire.

Diffusers.–You use diffusers when you want to change specular light to a softer, more diffused light. Diffusers are made of translucent or mesh materials that, when placed in the light beam, break up or diffuse and soften the light. The finer the mesh, the more diffused the light. When only a small amount of diffusion is needed, a wide mesh material, such as *gray* window screen, works well. For more diffusion, two pieces of screen can be placed together slightly out of alignment, or a finer mesh material, such as *white* cheesecloth, can be used. Floodlights initially produce a fairly diffused light, but diffusers may also be used with them. Diffusers can be mounted on the light unit or placed somewhere between the light unit and your subject.

There are many reasons for using a diffuser instead of a light that already produces diffused light. A diffuser may be needed when you do not have a soft light available. A softness that is between two different light sources may be needed, or you may want to produce a small area of diffused light that can only come from a spotlight with an installed diffuser.

Barn Doors.–Barn doors are made from opaque material. They are usually made of metal, painted black, and attached and hinged to the front of a light unit. They can be positioned to block or feather a portion of the light produced by the unit. Barn doors are made for both spotlights and floodlights. They are good accessories for controlling spill light.

Snoots.–Snoots are cylinders, open at both ends, usually made of metal and painted black. They are used at the front of a spotlight to limit the size of the circular area projected by the unit. Short, wide snoots give a large circle of light. Long, narrow snoots give a narrow circle of light. A cardboard tube or black-rolled paper can be used for a snoot when you need to improvise.

Umbrellas.–Umbrellas work much like the reflectors used on floodlights and provide an excellent means of converting specular light into soft, diffused light. They are used with any light source. The light unit is pointed away from the subject; the umbrella is attached in front of the light and reflects or bounces the light back and onto the subject. The reflected light falling on the subject is softer and more diffused than the light originally emitted by the source.

The reflecting surface of the umbrella determines the quality of the light. Umbrellas are usually made with a matte, white surface that provides a very soft, completely diffused light. Some umbrellas are constructed with a shiny, metalized surface. Metalized umbrellas throw a somewhat specular light, but the light is softer and spread over a larger area than the light emitted by the original light source.

FILM FOR PORTRAITS

For black-and-white portraits, black-and-white panchromatic film is generally used. With a pan film, the appearance of any red spots, veins, or redness in the subject's skin is apparently reduced in the final print, because of the sensitivity of the film to red. Conversely, an orthochromatic film can be used when the texture of a man's skin, especially an older man, is to be emphasized.

When you select a color film for portrait photography, there are two important considerations: What type of product is to be produced and what is the color of the light source?

Another factor to consider in selecting a film for portraiture is the ISO film speed in relation to the intensity of the light source. A slow film can be used successfully with a light source that has relatively high intensity, such as an electronic flash unit. When the same slow film is used with a light source that has relatively low intensity, an extremely wide aperture must be used. When a fast film is used with a high-intensity light source, a smaller aperture is required, increasing the depth of field which may not be desirable for portraiture.

When you are shooting portraits, do not be stingy with film. With a medium-format camera, you have 9 to 15 frames to work with. When you have the commanding officer or the admiral in the studio for a portrait, shoot at least the entire roll. Never shoot just three or four frames. Film is cheap and you want to provide the customer with a variety of poses and expressions to choose from.

MAKING THE APPOINTMENT

When possible, portrait times should be made by appointment. Using an appointment system gives you a

good start towards making a successful portrait. By using an appointment system, it tells your subject that he or she is important and will not be wasting time waiting to get into the studio. This brings the person to the studio with a positive attitude, and that is half the battle. An appointment also helps you. When an appointment system is used, you know how much time you have to work with each subject, and you do not have to rush through a sitting because someone else is waiting prematurely. Between appointments you have time to straighten up the studio, load film, complete job orders, screen processed portrait film, and so on.

Appointments should be made at least 15 minutes apart. This way you have time to take care of other business that may come up. If one customer is a few minutes late, you can also use this time to catch up.

When appointments are made, suggest to the person that they come in early in the day. Most people look their best and their clothes are fresher early in the day. Men, particularly those who develop a heavy beard (five-o'clock shadow), need to have their portraits made at the beginning of the day. However, they should not shave then come right in to be photographed. This provides time for facial blemishes, caused by shaving, to disappear.

Men should have a haircut and look sharp, but the haircut should be a day or two old. Uniforms should be pressed and well fitted with all awards, grade, and rating insignia properly placed. A chart of military awards and decorations is helpful in settling differences regarding the proper placement of ribbons and metals.

THE SUBJECT

When someone comes to the photo lab for a portrait, that person usually feels uncomfortable (like going to the dentist). Your attitude can help make the person feel relaxed. The secret to your success in putting the subject at ease is to convey a genuine and sincere attitude. Let the person know by your words and actions that you plan to do your best to produce a portrait that anyone would be proud to display.

Your attitude will leave a lasting impression on the subject and set the tone for the portrait setting. Greet the customer warmly, with a smile on your face as well as in your voice.

You, as the portrait photographer, should make it your business to know something about the subject. What is his job? Where does she work? How long has he been on board? What was her last duty station, and so on? The more you know about your subjects, the easier it is to work with them. Train yourself to gather a quick impression of the subject's intellect, taste, and aspirations. Talk to each of them and gather information regarding their special interests.

Conversation sooner or later strikes a responsive chord and the subject's face comes to life and gives you that natural expression so necessary to the finished portrait. Since the success of the portrait depends greatly on a natural expression, your task is to create a friendly situation whereby the subject feels he has an equal part. The making of a good portrait depends on cooperation. Do not rush a sitting and avoid getting flustered. You must always control the situation.

Invite your subject into the studio in a casual way. Have a bright light on, usually the main or modeling light. This way the shock of turning on a bright light in a dark studio is avoided. Ask the subject to be seated; a motion with your hand may be enough. A person who is treated in a friendly yet respectful manner, and kept in casual conversation, usually strikes a natural pose better than one who is not. If this fails, you must skillfully direct the subject. At times you may have to touch the subject to adjust a hat, sleeve, necktie, coat, and so on. Before touching the subject, explain to the person what action you are about to take.

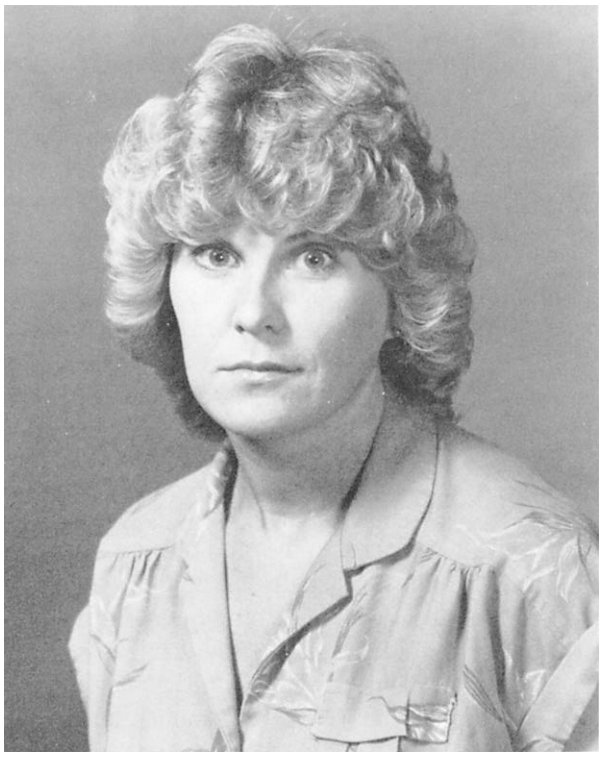
Talk to your subject and direct movements, from in front of the camera, within the circle of light. It is disturbing for the subject to hear a voice from a dark void trying to direct his or her movements.

Posing is the most unpredictable part of a portrait session. The subject is at a mental disadvantage because he has to follow your directions. This requires subtle handling on your part and an understanding of human behavior.

CAMERA HEIGHT

The best average camera height for a head-and-shoulders type of portrait is slightly above the subject's eye level. This places the subject's eyes well above the center of the picture space. Slightly above eye level then is a good place to start. Most portraits are made from this camera viewpoint, but individual features and characters of the subject often dictate a higher or lower camera position.

For three-quarter portraits, either sitting or standing, the camera height may need to be changed. For example,



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Figure 7-1.–Subject looking directly into the camera.



302.158

Figure 7-2.–Subject looking too far away from the camera.

you may want to start with the camera level at the upper chest or even at the eye level of the subject. Other factors that should be considered when selecting the camera height (especially with a head-and-shoulder portrait) include the shape of the subject's face and facial features, such as a long nose and the length of the subject's neck By changing the height of the camera in relation to the subject, you can make corrections to emphasize or de-emphasize features of the subject.

For full-length portraits, you should start with the camera height about waist level and the lens parallel to the subject. When the camera height is too high or too low and the camera lens is tilted, distortion of the subject occurs. When the camera is too low, the subject's feet appear large and the head small. When the camera is too high, the subject's head and upper body appear large and top heavy.

A camera position below the eye level of a subject can produce a side effect that may be distracting; that is, showing the nostrils more prominently and causing them to appear as two black holes. To help remedy this situation, you should place the modeling light higher to cast a shadow beneath the nose, so the nostrils appear to blend in with the shadow area.

POSING

The posing bench should be set at an angle to the camera. When the bench is square to the camera, people tend to sit on it with their shoulders square to the camera This puts their shoulders straight across the picture and such a pose exaggerates the width of the shoulders. This pose is obviously inappropriate for a woman. When your subject is a male dignitary (VIP), a pose like this enhances those qualities. Very few people have positions that demand such a pose. Having the posing bench at an angle to the camera before the sitter arrives should automatically suggest to the subjects that they sit with their shoulders turned slightly from the camera. With the shoulders turned slightly from the camera and the head turned back toward the camera, a sense of motion is created. Even more motion and alertness can be suggested by having the subject lean slightly forward.

Eye Direction

To create an intimate portrait, the subject appears to return a glance to the viewer. The subject's eyes should look near the camera lens (just above or to the side of it). When the subject looks directly into the lens, a stare

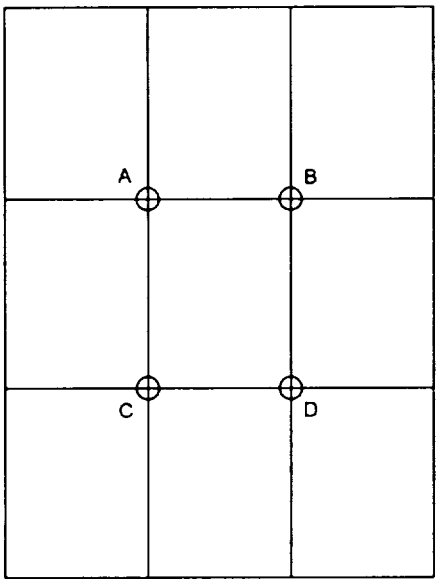


Figure 7-3.–Rule of thirds.

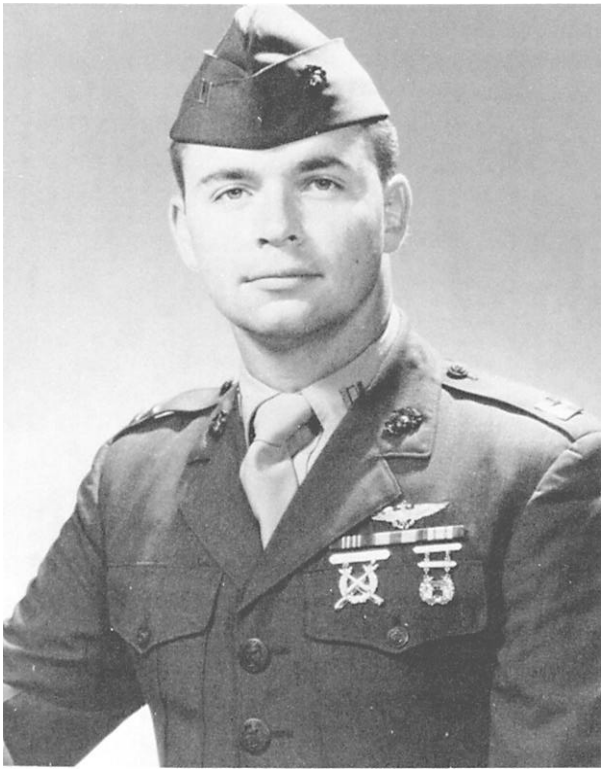
will result (fig. 7-1). When the eyes are looking too far away from the camera, a vague, faraway look results (fig. 7-2). The eyes also lose their brilliance and sparkle, and too much white shows when the subject's eyes are looking away from the camera.

Portrait Composition and Subject Placement

As in every type of photography, in portraiture there must be one, and only one, principal point of interest. Naturally, in a portrait, this is the subject's face. You can emphasize the point of interest in a portrait by doing the following:

- Having it contrast with the background
- Giving it the strongest lighting
- Posing the subject and arranging the props so all elements point to it
- Locating it at a strong point within the picture area

Where are the strong points within a portrait picture space? The *principle* of *thirds,* as discussed in chapter 5, applies to portraiture as well. These are the areas within a portrait that attract eye attention and are the preferred locations for the center of interest (fig. 7-3). In a portrait, when the main point of interest is located at Point A, the secondary point of interest should be at Point D. If B is the point of interest, C becomes the



302.159

Figure 7-4.–Subject placed too high in the photograph.

secondary interest point. Such an arrangement obviously balances the composition.

As stated earlier, the subject's face is the point of interest in a portrait and, of course, covers a considerable area in the picture space. Usually in portrait composition, the eyes fall close to Points A or B. But these positions are approximations only. The final adjustment of the head depends upon several factors: the eye direction, the shape of the body, and the leading lines. No rule can be given for best portrait composition. Rules only give guidance to a rough approximation of good placement. You can only arrive at the best composition for each portrait through the feeling for balance and subject position.

When the head and shoulders are placed high in the picture frame, a sense of dignity and stability is gained. Such placement is particularly appropriate when the subject is a person of importance, such as the CO. However, when the head is too high (fig. 7-4), viewing the picture is uncomfortable because there is a feeling that if the subject stood up he would bump his head. Also, when the head is too high, the proportion between head and body areas becomes awkward.



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Figure 7-5.–Subject placed too low in the photograph.

Most inexperienced photographers place the head too low, rather than too high. This is usually the result of the photographer's desire to show as large a head as possible. When the head is too low, there is not enough body to support it (fig. 7-5).

When the head is turned toward the side, avoid having the tip of the nose from coinciding with the outline of the cheek or projecting only slightly beyond the cheek line. In either case, the far eye will be divided by the nose. When the tip of the nose sticks out only a little beyond the cheek line, it appears as a lump on the cheek

Before you seat a subject, suggest that the subject may like to check his or her appearance in a mirror. Combing the hair, straightening a tie, setting a hat at the proper angle, and smoothing out the lay of the clothes should ensure a neat, well-groomed appearance. When the subject is in military uniform, be sure that medals, ribbons, insignia of grade or rate, and other accessories are worn properly. These minor details are easily overlooked and failure to correct a discrepancy may make it necessary to retake the portrait.

When a military subject is seated, one particularly important point to consider is the lay of the coat collar. The collar has a tendency to separate from the back of the subject's neck and project outward resulting in the impression of a hump. The coat should be pulled down to make the collar fit properly and make the line of the subject’s back appear free from slouch or slump. When the portrait includes only the head and shoulders, the drape of the coat can be improved by unbuttoning the lower button and pulling the bottom of the coat down.

The sleeves of a coat are another problem, particularly when you photograph a seated subject. There is a tendency for the sleeves to work up and wrinkle at the elbows, allowing either too much wrist or too much shirt cuff to show. To help remedy this, have the subject pull the sleeves of the coat down and straighten out the wrinkles as much as possible. Wrinkles, folds, and unwanted creases in a uniform detract from a neat appearance. When the subject is wearing a long-sleeved shirt under a coat and the hands will appear in the portrait, both shirt cuffs should be visible or both should be out of sight. Do not have one cuff visible and the other not.

Stay near the camera and tell the subject what to do. You are obligated to give directions regarding the pose. A subject is not able to see all posing aspects for the portrait. Whether the subject is an admiral or seaman, you are expected to detect and correct any discrepancy in pose, uniform, gestures, or actions, and so on. One of the greatest obstacles to successful portraiture is the timidness of some photographers and the way they handle the subject. Never take a portrait when something about the portrait is wrong because of fear or timidity to speak and act in the presence of high grade. The results will be disappointing and embarrassing.

When the military subject is to be photographed uncovered, be sure that the hat is removed far enough in advance so any impression on the forehead caused by the hatband has time to disappear.

When the subject shows a tendency to squint or blink, suggest that he rest his eyes by closing them for a moment. The facial expression is an important element to a good portrait. Unless some method is used to induce a pleasant expression, the subject will generally appear bored and uninteresting. Telling a subject to look this way or smile is not enough to cause the subject to smile. A forced smile sometimes looks more like a frown. A good method to get a pleasant expression is through conversation. Talk about a recent incident, a funny story, the weather, or any other topic that will cause the subject to concentrate on something other than the business of making a portrait. With most people, a smile is contagious. When you smile at a person, the person usually responds with a smile. Beware of a broad smile

because it rarely looks attractive, and it is usually not appropriate for a person in a military uniform. While you are trying to induce the expression that will show off the subject to the best advantage, be particularly observant of the details necessary to maintain a neat appearance and good composition.

FUNDAMENTAL PORTRAIT LIGHTING

The success of a portrait is equally dependent on lighting as on the pose of the subject. The manner in how the subject is lighted can actually set the mood of a portrait. The best portrait lighting will simulate natural sunlight. This is because we are accustomed to seeing faces illuminated from above and to one side with shadows cast downward and on one side or the other. Light coming from below eye level casts shadows upward and produces an unnatural, ghastly effect. Good portrait lighting shows off the subject to the best advantage, emphasizing the form and expressiveness of the facial features. When lighting appears pleasing and natural in a portrait, it produces prominent highlights on the forehead, nose, cheeks, and chin with enough shadows to round out the facial features.

Lighting for a studio portrait normally requires at least two lights. One of these is the *main, modeling,* or *key* light; the other is the *fill* or *fill-in* light.

Portrait lighting is divided into various types called lightings. Some of these lightings are as follows: broad, short, butterfly, Rembrandt, split, and rim. These names have been assigned because of the visual effects the lighting creates when it falls on the subject from a given direction. This visual effect is derived from the modeling light. Other light sources that may be added to the *modeling light* to enhance the subject are as follows:

- Broad lighting–The main light completely illuminates the side of the face turned toward the camera.

- Short lighting–The main light completely illuminates the side of the face turned away from the camera

- Butterfly lighting–The main light is placed directly in front of the face and casts a shadow directly under the nose.

- Rembrandt lighting–This is a combination of short and butterfly lighting. The main light is placed high and to the side of the face turned away from the camera and produces a triangle of light on the side of the face in shadow.

- Split lighting-The modeling light is placed to light completely one side of the face while placing the other side of the face in shadow.

- Rim lighting-The modeling light is placed behind the subject and places the entire face in shadow.

MAIN LIGHT

The main light is often called the *modeling* light because it is used to model the face (or subject). The main light creates a three-dimensional effect by either emphasizing or de-emphasizing the curvature and characteristic features of the face with highlights and shadows. The modeling light should always be the one dominant light source in a portrait because it controls the direction of the shadows.

The direction of the main light establishes four basic portrait lightings. These basic lightings are as follows: *three-quarter lighting, side lighting, frontlighting,* and *backlighting.* When reading other books on portrait lighting, you will often encounter other names depending on what the author wanted to call the lightings. You, as a Navy Photographer's Mate, will mostly be concerned with three-quarter (broad and short) and front (butterfly) lighting.

We also designate each of our lightings as high, medium, and low for vertical position. To go further, we designate the lighting as right or left of the subject.

These lighting positions change with each subject. When setting portrait lights, you should always study the effect and view the subject from the camera position, preferably through the viewfinder.

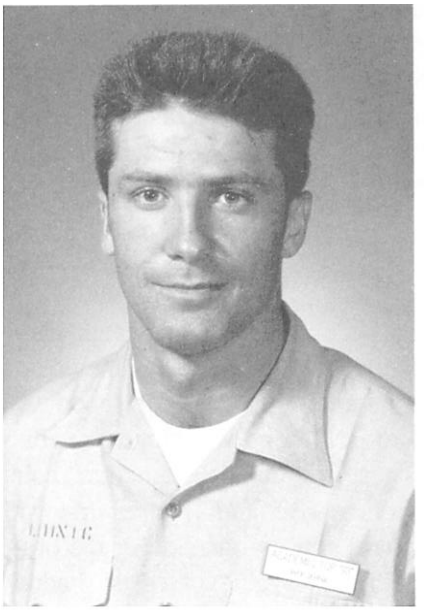
THREE-QUARTER LIGHTING

Broad and short lighting are two types of three-quarter lighting, and they are the types that you most often use for official portraits. The only difference between the two is the position of the main light and the way it illuminates the subject.

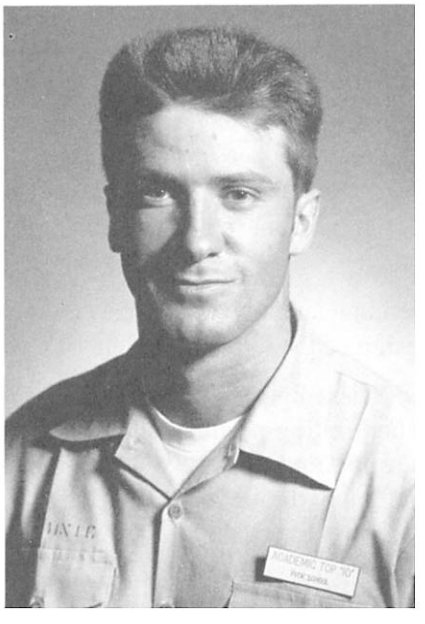
Short lighting is used for people with a normal shaped face or people who have a wide face. When short lighting is used, the side of the subject's face that is away from the camera is illuminated. This puts the side of the face towards the camera in shadow. By putting the side of the face towards the camera in shadow, you can provide a slimming effect.



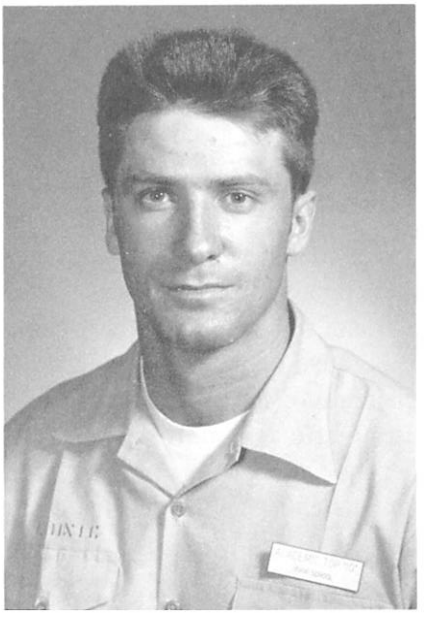
SHORT LIGHTING
MAIN LIGHT ONLY



SHORT LIGHTING
WITH FILL LIGHT



BROAD LIGHTING
MAIN LIGHT ONLY



BROAD LIGHTING
WITH FILL LIGHT

PH1 Casey Akins
302.310

Figure 7-6.–Broad and short lighting.

Broad lighting is useful for subjects with a narrow face. When broad lighting is used, the side of the face towards the camera is illuminated, and the side of the face away from the camera is in shadow. This provides a widening or broadening effect of the face. Refer to figure 7-6 to compare the differences of short and broad lighting.

Main Light Distance

The power or intensity of the main light is not the determining factor for the distance the main light is placed from the subject. It is the visual effect the light has on the subject that determines this distance. When the main light is too high and close to the subject, there

may be too much light falling on the forehead and not enough light falling on the lower part of the face. This effect can be improved by moving the main light farther away from the subject and placing it correctly.

Highlights on the forehead, the upper cheeks, the chin, and along the bridge of the nose are created by the main light. These highlights give life, brilliance, and form to a portrait, and the quality of these highlights are controlled by the main light distance.

To determine the main light distance, start with the light about 4 feet from the subject and about 2 feet above the subject's eye level. The light should be about a 45-degree angle to the lens axis. Observe the forehead highlight and move the light closer to the subject; as the light gets closer to the forehead, highlights spread out to a large, flat area and begin to wash out.

Now, start moving the main light away from the subject. As you slowly move it back, you will find there is a point where the forehead highlight becomes relatively small and bright. When the light is moved back much further from this point, the highlight spreads and disappears. Between the point where the highlight is brightest and where it starts to disappear lies the range where the highlight still has character. This point is where you get the most pleasing effect. Once you have found the distance where the main light gives your desired effect, the *distance* should remain the same regardless of the *direction* you need to move the light. This main light distance should always be considered as the *starting* point of portrait lighting.

Main Light Height

To determine the correct height for the main light, move the light directly in front of the subject while maintaining the distance determined for the forehead highlight. Raise or lower the light until the shadow cast by the nose is just long enough to touch the top edge of the upper lip. This is the height the main light should normally be no matter at what position you place it in an arc around the subject.

When your subject is wearing a hat with a visor, the visor shadow should fall naturally across the face. Many photographers think the shadow cast by the visor should not shade the eyes. The shadow from the visor *should* shade the eyes, however, in a portrait, this shadow should not be so dark that shadow detail is lost and the eyes are hard to see. To prevent this shadow from being too dark, raise the main light to the desired height, and instead of aiming it down at an angle, aim it straight. This way the light is cast under the visor and prevents the shadow from becoming too dark

Main Light Direction

By the time you have determined the main light distance and the height for a given subject, you should have a pretty fair idea of the direction you want the main light to come from. To establish the direction from which this light should come, move the main light in an arc, to the right or left, around the subject. Remember, while moving the main light, its established distance and height should be maintained.

The shadow cast by the subject's nose is your key to main light direction. The light should be moved around until the shadow cast by the nose merges with the cheek shadow and leaves a small, triangular highlight on the cheek. When this is done, the main light is in position. Remember, the main light must always be the dominant, directional, shadow pattern forming light.

Fill-in Light

Once the main light has been established, the fill or fill-in light is added. This fill light is a secondary light and must not overpower the main light. Its purpose is to fill in and soften the shadow areas, making them lighter, and to provide shadow detail.

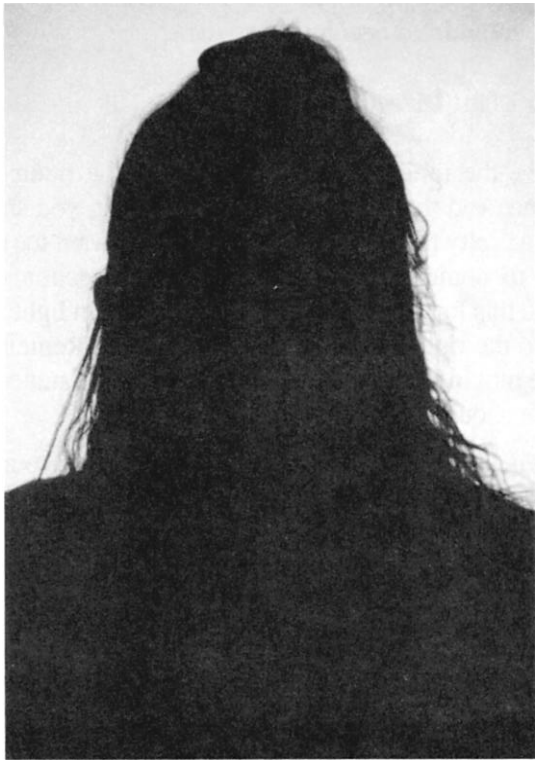
The fill light is normally placed slightly above the subject's eye level, on the opposite side of the camera from the main light and near the camera lens axis. The fill-in light should be less intense than the main light and of softer quality. This light is often diffused even when the main light is not.

By placing the fill light slightly above the subject's eye level, you can cast a shadow under the chin. This shadow separates the head from the neck. The chin shadow should be soft and unpronounced.

The intensity of the fill-in light can be controlled by either adjusting the power setting of an electronic studio light set or adjusting the light-to-subject distance. The fill light can be moved in an arc to the side of the subject and away from the camera. The fill light must not produce conflicting shadows (shadows that point toward the main light).

Catch Light

There should be a small, bright reflection of the main light in the eyes of the subject. This is a catch light. The catch light adds life and brilliance to a portrait and



PHC Carl Hinkle
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Figure 7-7.–Effect of background light.

gives the eyes sparkle. There should be only one catch light in each eye, and it should be high in the iris of the eye. For broad lighting, the catch light should be approximately in the 11 o'clock position. The main light for short lighting should create a catch light at approximately the 1 o'clock position.

Lighting Ratio

The lighting ratio for portraits should usually be about 3:1 or 4:1-3:1 is about maximum for good color portraits. To refresh your memory on how to establish lighting ratios, refer to chapter 5.

Background Light

The third light in studio portrait lighting is the background light. A background light is usually placed on a low stand midway between the background and the subject. When adjusted correctly, the background light provides good tonal separation between subject and background. The intensity of the light falling on the background should not normally be greater than the intensity of the light from the main light falling on the subject's face. By increasing or decreasing the intensity of the light on the background, you can control the tone or color reproduction of the background in the finished print.

To reproduce the background color to its “true” color in a color print, it must receive the same amount of light as the subject's face. When taking portraits for use on a roster board, you want the tone and color of the background to be consistent. When the backgrounds vary in color, the roster board does not appear uniform, and the attention of the viewer is distracted.

When a background light is used, it is wise to position it before setting up any other light. It is easier to determine its effect without the interference of the main and fill light. The background light should be positioned so the brightest area of the light illuminates the background directly behind the head and gradually falls off into the corners of the frame (fig. 7-7). When the background light is set in this manner, it separates the head from the body and draws the viewer’s attention to the subject's face.

Hair Light

Once the main, fill. and background lighting is established, additional lights may be added to the setup. One such light is a hair light. A hair light is usually a small lighting unit placed on a boom so it shines down from above and behind the subject. It is used to lighten the hair (or hat) and shoulders, add detail to the hair, and separate the subject from the background, presenting the illusion of a third dimension (fig. 7-8).

The intensity of the hair light varies with the subject since it is dictated not only by the color of the person's hair (or hat) but also by the amount of sheen the hair has.

The hair light is usually placed on the side of the subject opposite the main light and behind the subject. It should be used from an angle about 6 to 8 feet high and from a position close to the center of the subject area without the light stand or boom showing in the picture. Light from this unit should not be allowed to spill over onto the forehead or tip of the nose. The hair light normally has a snoot attached so light from it does not strike the camera lens.

Be sure the hair light is turned off when making any exposure readings. This light does not affect your basic film exposure, but it could influence your meter.



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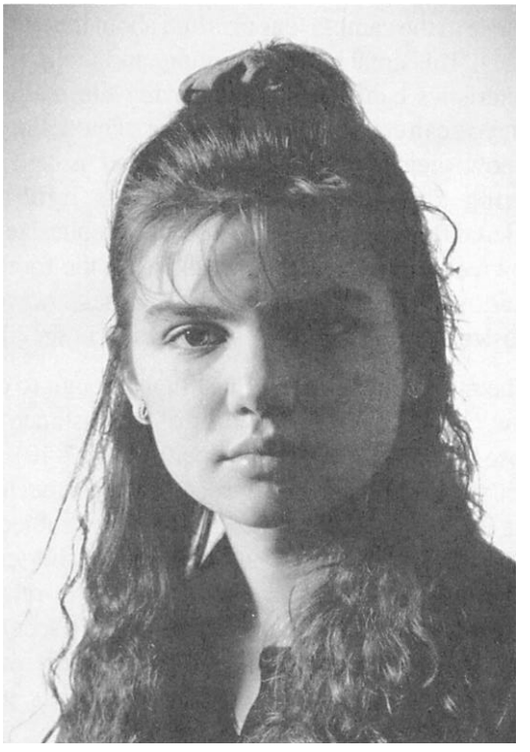
Figure 7-8.–Effects of hair light.

Flexibility of Three-Quarter Lighting

Three-quarter lighting can be used with almost any type of face. It is flexible because once it is set, the subject can move his head from full face to profile and the lighting remains good at any point you choose to pose the sitter. The degree of flexibility is determined by the type of light used (spot or flood) and the size and type of reflector used.

SIDE LIGHTING

With side lighting, the face is lit more intensely on one side than the other (fig. 7-9). This type of lighting is well suited for young women that have smooth skin and regular facial features, or for men whose rugged character lines should be emphasized. As a Navy Photographer's Mate, you will not normally use side lighting for official portraits. To learn more about side lighting, refer to the reference list in the back of this training manual.

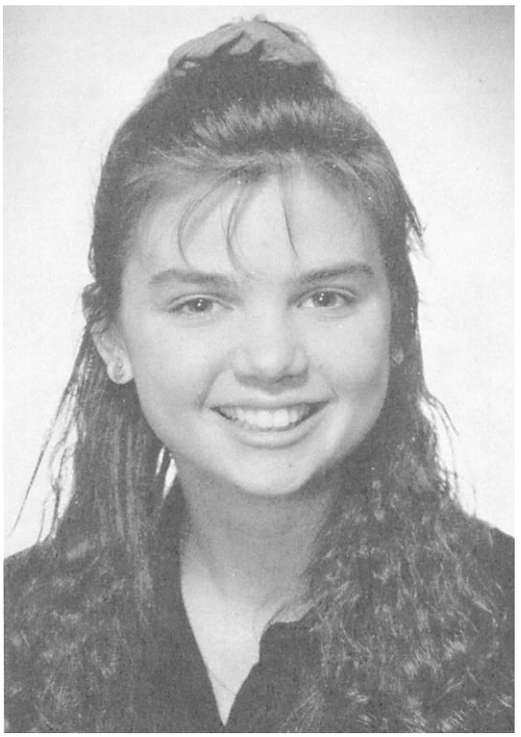


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Figure 7-9.–Side lighting.

BUTTERFLY LIGHTING

Butterfly lighting is often used when making portraits of women. To start, you can place the main light



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Figure 7-10.–Butterfly lighting.

very close to the camera lens axis and about the subject's eye level. This creates a flat lighting, and facial feature characteristics can be lost. By moving the main light higher, you can create a certain amount of modeling. The light now creates a little modeling and is still very flattering and almost foolproof. This lighting is considered flattering because it does not emphasize lines or crowfeet around the eyes, wrinkles on the forehead, or shadows around the mouth. It does, however, emphasize eyes and eyelashes, especially in females.

The main light should be just high enough to cast a shadow of the nose about a third of the distance from the nose to the top edge of the upper lip (fig. 7-10). Each subject's face and nose is different, so the correct height for the main light varies slightly. When the subject has a long nose, the light should be low to shorten the shadow. When the subject has a short nose, raise the main light to lengthen the shadow. This has a secondary effect as well. It adds form below the eyebrow and accentuates any slight hollowness in the cheeks, giving a more provocative look.

When making a portrait of a person smiling, you must shorten the nose shadow because the upper lip draws up and the shadow goes over the lip. The nose shadow should not extend over or touch the edge of the lip. When it does, the lip form is destroyed and it appears unnaturally small.

The main light-to-subject distance is again determined using the forehead highlight test.

The fill-in light is positioned directly below the main light-close to the camera lens axis and slightly above the subject's eye level. The intensity of this light should be about one f/stop less than the main light. The lighting ratio is established by moving the fill light closer to or farther away from the subject to increase or decrease its effect. Balance also can be controlled by using diffusion screens over the fill-in light.

Although not as flexible as three-quarter lighting, frontlighting does have some flexibility. The subject's head can be posed from full face to profile. However, the nose shadow must always remain under the nose. Therefore, the main light must be moved with the head; and as the head moves to the three-quarter or profile position, the hair light also must be moved. The fill light is not moved.

RIM LIGHTING

Rim lighting is often used when making profile portraits. Rim lighting is the same as backlighting, where the subject is lighted from behind causing the facial features of the profile to be highlighted (fig. 7-11). Some suggestions to use when taking profile portraits are as follows:

- In a profile portrait, when a person looks straight ahead, only the whites of the eyes are seen by the camera. This causes an undesirable effect. Instead have the eyes cheat-turn the eyes slightly toward the camera, without turning the head, to show enough of the iris so the eye can be seen as an eye, not a white ball.
- Have the subject's head tipped back slightly. This separates the chin from the far shoulder, gives a better neckline, and reduces the appearance of a double chin.
- Allow more space on the side of the picture toward which the eyes are looking. This allows the subject to "look" beyond the frame.

If you are interested in learning more about rim lighting, refer to the reference list in appendix III.



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Figure 7-11.–Rim lighting.

FULL-LENGTH PHOTOGRAPHS

Officers of the Navy and Naval Reserve, in grades CWO3 through CWO-5, or O-3 through O-8, must submit a full-length photograph of themselves before being selected for promotion to the next higher rank. Other special selection boards require a full-length photograph to be included in the applicant's package, such as the limited duty officer program, Sailor of the Year, and other programs in which a selection board process is used. Candidates for officer promotion and LDO or CWO selection boards should refer to *NAVPERS Manual*, 15560C, and *NAVMILPERS-COMINST, 1131.1A*, respectively, for the most current information.

BACKGROUND

Since the studio setup is unique for full-length photographs, they should be scheduled at a time other than that of normal head-and-shoulders portraits. The background for full-length photographs must be a contrasting color from the uniform of the subject. Normally, white seamless paper is used because it provides the best results.

When white seamless paper is used for full-length portraits, it must drape down and provide enough coverage for the subject's head and extend to the deck so the subject is standing on it. You should protect the background from footprints and tears by laying down a protective material, such as paper or acetate.



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Figure 7-12.–Full-length photograph.

LIGHTING

When lighting a full-length portrait, you must light the entire body of the subject evenly and not allow objectionable shadows to show on the final product. This is best achieved when the subject is lighted with light diffused from two umbrellas. The background can be evenly lighted with two background lights. You should always conduct tests to determine the best lighting setup for your studio equipment and facilities.

POSE AND COMPOSITION

The full-length officer portrait must be a three-quarter view with the left shoulder forward. For officer promotion photographs, the prescribed uniform is summer khakis (summer whites where summer khakis are not authorized) and dress blues for LDO or CWO applications. All subjects will be uncovered unless otherwise stated in the applicants appropriate instruction. A menu board or hand- lettered title board must be placed at the subjects feet and be legible in the final photograph. The subject should be

centered both horizontally and vertically in the photograph (fig. 7-12).

The best camera and film to use for a full-length photograph is a 4x5 camera and a Polaroid 4x5 film back When this combination is used, the customer can leave the studio with the final product. Any camera or imaging system can be used, depending on your imaging facilities capabilities, providing that two 4x5-inch prints are furnished to the customer.

CORRECTIVE TECHNIQUES

The primary goal in portrait photography is to present the subject in a favorable and flattering manner. Your most difficult problem is combining the pose, lighting, and camera viewpoint to show your subject to best advantage. Because the photogenic qualities of each person's face vary, certain corrective techniques in posing, lighting, and camera heights can be used to help depict the subject favorably and improve the quality of the portrait. Changing the camera viewpoint, combined with proper lighting and pose, can create amazing alterations in the pictured appearance of any face. Table 7-1 shows corrective techniques and ways they can be used to correct common problem areas.

EXPOSURE CALCULATION FOR STUDIO PORTRAITS

Normally, the exposure for portraits should be based on the fill light alone as measured at the subject position. The fill light is the single source of illumination to the shadow areas and image detail in the shadow areas.

Table 7-1.–Corrective Treatments

Problem	Treatment
Fat, round face	Shoot three-quarter view, light side of face away from camera Use three-quarter or side lighting
Thin face	Shoot front, full face Use low three-quarter or side lighting
Wide forehead	Use low-camera viewpoint Tilt chin upward
Narrow forehead	Use high-camera viewpoint
Baldness	Use low-camera viewpoint Little or no hair light Blend head with background
Eyes close together	Shoot three-quarter pose
Eyes far apart	Shoot three-quarter pose
Small eyes	Shoot three-quarter pose Use three-quarter lighting so the eyes are in shadow
Large or protruding eyes	Use high three-quarter lighting Lower eyes slightly
Deep set eyes	Low-camera viewpoint Use frontlighting to keep eyes out of shadow
Uneven eyes	Turn head toward one side so natural perspective eliminates uneven appearance
Bags under eyes	Use makeup. Use frontlighting
Cross eyed or defective eye	Turn head so bad eye is away from camera. Light side of face toward camera to place other eye in shadow

Table 7-1.–Corrective Treatments–Continued

Problem	Treatment
Glasses	Use high front, three-quarter, or side lighting to eliminate reflections Raise the temple piece up slightly to angle lenses down lilt head downward Shoot full-face pose to prevent lenses from splitting cheek line Use indirect diffused lighting
High cheeks	Use low front or side lighting
Wide cheeks	Shoot three-quarter pose
Small ears	Turn head so camera sees only one ear Place exposed ear in shadow
Large ears	Turn head so camera sees only one ear Place exposed ear in shadow
Protruding ears	Turn head so camera sees only one ear Place exposed ear in shadow Shield light from exposed ear Blend ear into background
Long nose	Use low-camera viewpoint Use three-quarter or side lighting Apply dark makeup to tip of nose
Short nose	Use high-camera viewpoint Use frontlighting
Hooked nose	Shoot from a low-camera viewpoint Shoot front, full face
Crooked nose	Shoot from the side to which it curves Turn head until highlight along ridge of nose appears straight
Broad nose	Pose head away from a front view
Narrow mouth	Use lip color to extend lip line Turn head to one side so makeup is not apparent Position modeling light high to cast shadows at ends of lips
Wide mouth	Pose head in three-quarter view
Protruding lips	Use low-modeling light to eliminate shadow under lips
Thin lips	Fill out with lip color
Uneven mouth	Pose head in three-quarter view
Bad teeth	Do not have subject smile
Buck teeth	Subject may smile slightly Use full, front pose
Long chin	Use high-camera viewpoint

Table 7-1.–Corrective Treatments–Continued

Problem	Treatment
Double chin	Keep chin in shadow Have subject lean forward and look at camera
Small chin	Use full, front pose Use low-camera viewpoint
Square face	Use high-camera viewpoint
Oval face with a weak chin	Use low-camera viewpoint
Short neck	Use low-camera viewpoint
Long neck	Use high-camera viewpoint Keep neck in shadow
Facial blemishes	Keep in shadow Turn bad side of face from camera Apply makeup to a pimple or sore spot

When the exposure is based on the illumination intensity of the main light, the indicated f/stop produces underexposed shadow areas of the negative. With black-and-white negative film, the underexposure to the shadow areas may not be enough to cause loss of shadow detail. This is because of the greater exposure latitude and film processing latitude of black-and-white film compared to color negative film. With color negative film, however, underexposure to the shadow areas may cause loss of shadow detail and a color shift in the shadow areas that is uncontrollable in printing. Remember, basing your portrait exposure on the fill light alone applies only when the lighting ratios are within about a 2:1 to 4:1 range. Beyond a 4:1 lighting ratio, you may have to calculate your exposure based on both the main and fill lights.

PASSPORT PHOTOGRAPHS

Passport photographs should only be provided to United States military personnel, their dependents, and employees of the federal government when required for executing official orders. Providing such photography for purposes and to individuals other than this is an infringement of the rights and commercial enterprise and may violate U.S. Navy Regulations.

Passport photographs are normally taken on Polaroid film with a camera designed for passport photographs. The photographs must portray a good likeness of, and satisfactorily identify the applicant. Passport photographs must meet the following requirements:

- Photographs must be 2x2 inches in overall size. The image size, measured from the bottom of the chin to the top of the head (including hair), shall be not less than 1 inch or more than 1 3/8 inches. A quick method to determine the correct image size is the head should fit inside the frame of a 35mm slide mount.
- Passport photographs may be in color or black and white. Black-and-white photographs that have been tinted or otherwise colored are not acceptable. Prints which have been retouched to the extent that the applicant's appearance has been changed are also not acceptable. However, prints that have been retouched merely to eliminate shadows and lines are acceptable.
- Photographs that depict the applicant as relaxed and smiling are encouraged. Photographs should be portrait-type prints, meeting the size and image specifications listed above. Photographs must be clear, front view, full face, with a light, plain background.
- A passport photograph serves to identify the passport applicant. When glasses, a hearing aid, a wig, or similar articles are normally worn, these

articles should be worn when the photograph is made. Dark glasses with tinted lenses are not acceptable, unless required for medical reasons.

- Photographs should be made in normal street attire without a hat or other headgear that obscures the hair or hairline. Only applicants in the active service of the armed forces and who are proceeding abroad in the discharge of their official duties may submit photographs in the uniform of the U.S. Armed Forces. Other uniforms should not be worn in passport photographs.
- Photographs should be able to withstand temperatures up to 225°F (107°C) for 30 seconds.
- Photographs must be printed on thin paper so the seal and legend can be applied to the photograph.
- Automatic and self-developing prints are acceptable for passport photographs, providing they meet all other photographic specification. SX-70 and black-and-white Polaroid prints are not acceptable.
- Matte- or dull-finished photographs are preferred, but shiny or glossy prints may be accepted, provided the signature ink will stick to the surface of the photograph. Matte or other sprays designed to produce a dull or nonglossy finish should not be used.

PERSONNEL IDENTIFICATION PHOTOGRAPHY

The requirement for speed in identification photography makes it impractical to produce the same quality expected in portrait work However, with a little attention to the details of lighting, posing, and exposure, high-quality photographs can be provided.

Occasionally, a profile or three-quarter view may be required for naturalization photographs. However, most identification photos are made with the subject facing the camera and looking straight into the lens. Since identification photographs must reveal as much facial detail as possible, very few are flattering pictures.

CHAPTER 8

COPYING

The term *copying,* as used in photography, means producing a photograph from a photograph, map, painting, or similar flat document. A document that is copied is called the "copy original" or "original," and the products of the copying process are called "reproductions*' or "copies." Originals are broadly classed as reflection originals and transparent originals. The photographic reproduction can be any size in relation to the original document.

Copying is a large and important part of naval photography. It provides an important service to most every aspect of the Navy-from the Intelligence Specialist giving a training lecture, to the admiral who needs 100 copies of a map for planning an invasion.

Photographic copying is an accurate, inexpensive, and quick way of reproducing originals. Copying is skilled work and you must give it the same careful attention that you give to other types of photography. Making good photographic copies is an accomplishment any photographer can be proud of. A knowledge of copying techniques extends your skill as a Navy photographer and makes you more useful to yourself and the Navy.

The process of copying is complicated by the extensive variation in the type of originals to be copied and the varying conditions under which the work is done. The materials to be copied range from simple line drawings to transparencies that are used daily aboard ship and at shore stations. Films used for copy photography are processed much the same as films for other photography. They can be processed by hand, in trays and tanks, or processed by machine.

COPY TERMINOLOGY

Copying–Photographing flat documents, such as photographs, drawings, blueprints, charts, and so forth.

Original–Material from which copies are made, such as handwritten copy, typed copy, printed matter, tracings, drawings, and photographs.

Halftone–Reproduction by printing processes, such as lithography of a photograph in which the gradation of tone is reproduced by a pattern of dots and intermittent white spaces, caused by interposing a halftone screen between the lens and the film. (See fig. 8-1.)

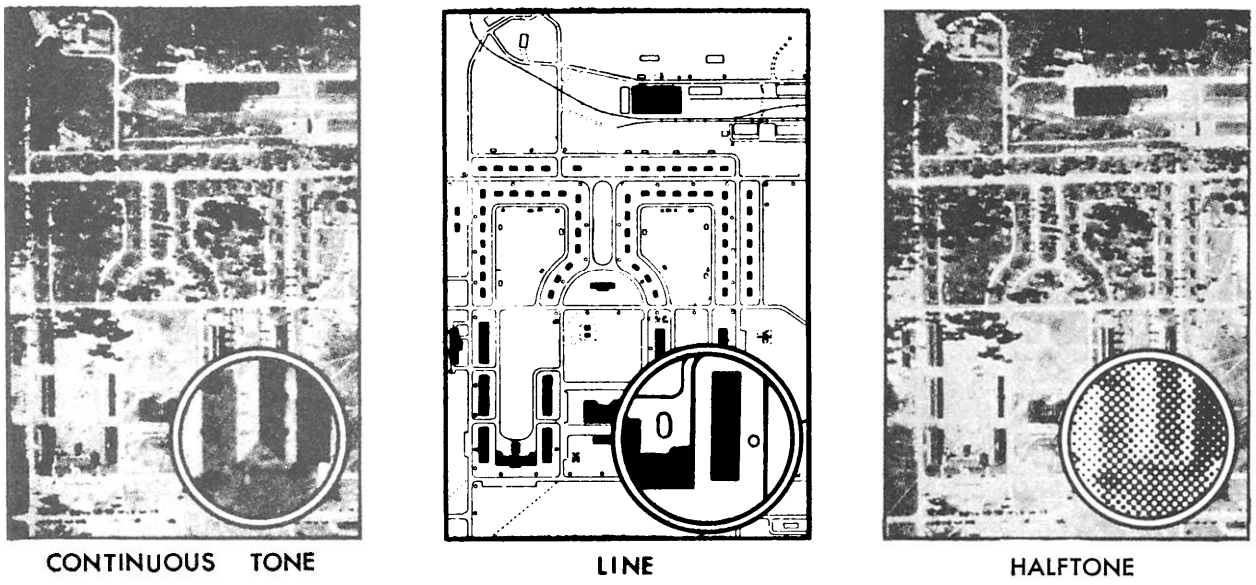


Figure 8-1.–Comparison of continuous tone, line, and halftone.

Line Original–A document or drawing consisting essentially of two tones (such as black and white, black and tinted, or brown and buff) without intermediate tones.

Continuous-Tone Original–Materials in which the detail and tone values of the subject are reproduced by an infinite gradation of gray densities between white and black

Copy Negative–A photographic film negative made as an intermediate from which prints are made.

Reproduction–The duplication of original copy by any photographic process.

Copyboard–The board, easel, frame, or other device for holding originals to be copied.

Reflex Copying–A method of contact printing in which light passes through the sensitized paper and emulsion, strikes the material being copied, and reflects back to the emulsion, producing a reversed reproduction of the original.

Restoration-Copying old, faded, or damaged material to produce a more presentable or legible copy.

Duplicating-Producing copies of negatives or slides for use instead of the originals.

Intermediate Positive-A positive transparency of a negative used for making more negatives.

Intermediate Negative (Interneg)–A negative made from a positive transparency that is then used to make reflection prints.

COPYRIGHT

On January 1, 1978, a new copyright statute came into effect in the United States. Some highlights from the law are given here. For specific details about the law or to gain copies of the statute and regulations, send a specific written request to the following: Copyright Office, Library of Congress, Washington, DC 20559.

Copyright Protection

Copyright is a form of protection provided by the laws of the United States to the authors of "original works of authorship" including photographs. This protection is available to both published and unpublished works. The Copyright Act generally gives the owner of the copyright the exclusive right to do and to authorize others to do the following:

- To reproduce the copyrighted work
- To prepare *derivative works* based upon the copyrighted work
- To distribute copies of the copyrighted work to the public by sale or other transfer of ownership or by rental, lease, or lending
- To display the copyrighted work publicly in the case of literary, musical, dramatic, and choreographic, or sculptural works, including the individual images of a motion picture or other photographic work

It is illegal for *anyone* to violate the rights provided to an owner of a copyright. These rights, however, are not unlimited in scope. The Copyright Act establishes limitations on these rights. In some cases, these limitations are specified exemptions from copyright liability. Generally however, it is unlawful to reproduce, without written consent of the copyright owner, any material bearing a notice of copyright. The guiding rule in copying is to secure written permission from the copyright owner before starting work

What Is Protected

Copyright protection exists for original works of authorship when they become fixed in a tangible form of expression. The fixation does not need to be directly perceptible, so long as it may be communicated with the aid of a machine or device. Copyrightable works include the following categories:

- Literary works
- Musical works, including any accompanying words
- Dramatic works, including any accompanying music
- Pantomimes and choreographic works
- Pictorial, graphic, and sculptural works
- Motion pictures and other imaging works and sound recordings

This list is illustrative and is not inclusive of the categories of copyrightable works. These categories should be viewed quite broadly.

What Is Not Protected

Several categories of material are generally not eligible for statutory copyright protection. Among others include the following:

- Works that have not been fixed in a tangible form of expression
- Titles, names, short phrases, and slogans; familiar symbols or designs; mere variations of typographic ornamentation, lettering, or coloring; mere listings of ingredients or contents
- Ideas, procedures, methods, systems, processes, concepts, principles, discoveries, or devices, as distinguished from a description, explanation, or illustration
- Works consisting *entirely* of information that is common property and containing no original authorship; for example: standard calendars, height and weight charts, tape measures and rules, and lists or tables taken from public documents or other common sources

Copyright Secured Automatically upon Creation

The way that copyright protection is secured is frequently misunderstood. No publication or registration or other action in the Copyright Office is required to secure a copyright under the law. Copyright is secured *automatically* when the work is created, and a work is "created" when it is fixed in a copy or imaging recording for the first time. In general, "copies" are material objects from which a work can be read or visually perceived either directly or with the aid of a machine or device, such as books, manuscripts, sheet music, film, videotape, or microfilm. Phonograph records are material objects embodying fixations of sounds (excluding, by statutory definition, motion picture sound tracks), such as audio tapes and phonograph disks. Thus, for example, a song (the "work") can be fixed in sheet music (copies) or in audio recordings, or both.

Notice of Copyright

When a work is published under the authority of the copyright owner, a notice of copyright should be placed on all publicly distributed copies. This notice is required even on works published outside of the United States. Omission or errors will not necessarily result in forfeiture of the copyright. Therefore, just because a copyrightable material does not have a copyright notice does not mean it is not copyrighted. However, infringers misled by the omission or error of copyright notice will be shielded from liability.

How Long Copyright Protection Lasts

The copyright law changed in 1978. The time that the copyright on original material expires is determined by when it was created.

WORKS ORIGINALLY COPYRIGHTED ON OR AFTER JANUARY 1, 1978.–A work that is created (fixed in tangible form for the first time) on or after January 1, 1978, is automatically protected from the moment of its creation. It is ordinarily given a term enduring for the author's life, plus an additional 50 years after the author's death. In the case of a joint work prepared by two or more authors that did not work for hire, the term lasts for 50 years after the last surviving author's death. For works made for hire and for anonymous and pseudonymous (fictitious name) works (unless the author's identity is revealed in Copyright Office records), the duration of copyright is 75 years from publication or 100 years from creation, whichever is shorter.

Works that were created before the 1978 law came into effect, but were neither published nor registered for copyright before January 1, 1978, have been automatically brought under the statute and are now provided federal copyright protection. The duration of copyright for these works is generally computed in the same way as for new works: the life plus 50 and the 75 or 100 year terms apply to them as well. However, all works in this category are guaranteed at least 25 years of statutory protection.

WORKS COPYRIGHTED BEFORE JANUARY 1, 1978.–Under the law in effect before 1978, copyright was secured either on the date a work was published or on the date of registration if the work was registered in unpublished form. In either case, the copyright endured for a first term of 28 years from the date it was secured. During the last (28th) year of the first term, the copyright was eligible for renewal. The new copyright law has extended the renewal term from 28 to 47 years for copyrights that were still in existence on January 1, 1978.

International Copyright Protection

There is no such thing as an "international copyright" that will automatically protect an author's writings throughout the entire world. Protection against unauthorized use in a particular country depends, basically, on the national laws of that country. However, most countries do offer protection to foreign works under certain conditions, and these conditions have been greatly simplified by international copyright treaties and conventions.

The United States is a member of the Universal Copyright Convention (UCC). Generally, a work by a national or resident of a country that is a member of the UCC, or a work first published in a UCC country, may claim protection under the UCC.

Works of the United States Government

Works produced for the U. S. Government by its officers and employees as part of their official duties are not subject to U.S. copyright protection. The law makes it clear that this prohibition applies to unpublished works as well as published ones.

Fair Use

U.S. copyright laws specifically recognizes the principle of "fair use" as a limitation on the exclusive rights of copyright owners. The law considers factors in determining whether particular uses fall within this category. Listed below are the minimum standards of educational fair use of copyrighted works under the law. The guidelines are not intended to limit the types of copying permitted under the standards of fair use.

I. SINGLE COPYING FOR TEACHERS:

A single copy may be made of any of the following by or for a teacher at his or her individual request for his or her scholarly research or use in teaching or preparation to teach a class:

A. A chapter from a book

B. An article from a periodical or newspaper

C. A short story, short essay, or short poem whether or not it is from a collective work

D. A chart, graph, diagram, drawing, cartoon, or picture from a book, periodical, or newspaper.

II. MULTIPLE COPIES FOR CLASSROOM USE:

Multiple copies (not to exceed in any event more than one copy per pupil in a course) may be made by or for the teacher giving the course for classroom use or discussion *provided that:*

A. The copying meets the test of brevity and spontaneity as defined below; and,

B. Meets the cumulative effect test as defined below; and,

C. Each copy includes a notice of copyright.

III. PROHIBITIONS AS TO I AND II ABOVE:

Notwithstanding any of the above, the following shall be prohibited:

A. Copying shall not be used to create or to replace or substitute for anthologies, compilations, or collective works. Such replacement or substitution may occur whether copies of various works or excerpts therefrom are accumulated or are reproduced and used separately.

B. There shall be no copying of or from works intended to be "consumable" in the course of study or of teaching. These include workbooks, exercises, standardized tests, and test booklets and answer sheets and like consumable material.

C. Copying shall not:

1. substitute for the purchase of books, publisher's reprints, or periodicals;

2. be directed by higher authority; and

3. be repeated with respect to the same item by the same teacher from term to term.

D. No charge shall be made to the student beyond the actual cost of the photocopying.

Each Navy photo lab should have a copy of SECNAVINST *5870.5, Permission to use Copyrighted Materials in the Department of the Navy.* All Photographer's Mates should be familiar with its general content. It should be the basic instruction you should use when the question of copyright comes up. Here are a few excerpts from the instruction:

> "As a general proposition, copyrighted works may not be used without permission of the copyright owner. Unauthorized use is a copyright infringement, . . the U.S. Government has no general exemption from copyright infringement liability. Government employees are not, however, personally liable for copyright infringement occurring in the performance of their official duties."

> ". . . it is a criminal offense to remove or alter any notice of copyright appearing on a . . . copyrighted work, . . ."

COPY RESTRICTIONS

Federal laws regulating photography are intended to prevent counterfeiting and fraud and are located generally in Title 18 of the United States Code.

Designated government officials are charged with safeguarding the nation's currency. It is the belief of the United States Secret Service that granting permission to photograph and reproduce pictures of money, in color,

DEFINITIONS:

Brevity :

1. Poetry: (a) A complete poem if less than 250 words and if printed on not more than two pages, or (b) from a longer poem, and an excerpt of not more than 250 words.

2. Prose: (a) Either a complete article, story, essay of less than 2,500 words, or (b) an excerpt from any prose work of not more than 1,000 words or 10% of the work, whichever is less, but in any event a minimum of 500 words.

Each of the numerical limits stated in 1 and 2 above may be expanded to permit the completion of an unfinished line of a poem or of an unfinished prose paragraph.

3. Illustration: One chart, graph, diagram, drawing, cartoon or picture per book or per periodical issue.

4. "Special" works: Certain works in poetry, prose, or in "poetic prose" that often combine language with illustrations and which are intended sometimes for children and at other times for a more general audience that fall short of 2,500 words in their entirety. Paragraph 2 above notwithstanding such special works may not be reproduced in their entirety; however, an excerpt comprising not more than two of the published pages of such special work and containing not more than 10% of the words found in the text thereof, may be reproduced.

Spontaneity:

1. The copying of the material is for only one course in the school in which the copies are made.

2. Not more than one short poem, article, story, essay or two excerpts may be copied from the same author, nor more than three from the same collective work or periodical volume during one class term.

3. There shall not be more than nine instances of such multiple copying for one course during one class term.

The limitations stated in 2 and 3 above shall not apply to current news periodicals and newspapers and current news sections of other periodicals.

seriously weakens the safeguards designed to protect our currency.

As a Navy Photographer's Mate, you may be asked to copy United States and foreign financial certificates, such as obligations and securities. These may be needed for anything from the station newspaper to criminal investigations.

Provided below is information and conditions under which you are permitted to make copies of United States and foreign obligations and securities.

Paper Money, Checks, and Bonds

Printed illustrations of paper money, checks, bonds, and other obligations and securities of the United States and foreign governments are allowed for educational, historical, and newsworthy purposes. Illustrations must be in black and white and must be less than 3/4 or more than 1 1/2 times the size of the genuine original. No individual facsimiles of such obligations are permitted, and no illustrations of paper money, checks, or bonds may be in color.

To be permissible, an illustration must be accompanied by educational, historical, or newsworthy information relating directly to the item that is illustrated. Illustrations used primarily for decorative or eye-catching purposes are not allowed.

Motion-picture film and slides of paper money, checks, bonds and other obligations and securities of the United States and foreign governments are permitted in black and white or in color for projection upon a screen or for use in telecasting. Treasury regulations permit the illustration of United States bonds in connection with a campaign for the sale of such bonds.

United States and Foreign Postage Stamps

Printed illustrations of canceled and uncanceled United States postage stamps are permissible for articles, books, journals, newspapers, educational, historical, and newsworthy purposes.

Black-and-white illustrations may be of any size. Colored illustrations of canceled United States postage stamps may be of any size. However, illustrations in color of uncanceled United States postage stamps must be less than 3/4 or more than 1 1/2 times the size of the genuine stamp.

Printed illustrations of canceled foreign stamps in black and white or color are permissible in any size and for any purpose.

Black-and-white and color illustrations of uncanceled foreign postage stamps are permitted for educational, historical and newsworthy purposes, Black-and-white illustrations may be of any size, but color illustrations must be less than 3/4 or more than 1 1/2 times the size of the genuine stamp.

Motion picture films and slides of the United States and foreign postage stamps are permissible in black and white or in color for projection upon a screen or for use in telecasting.

Revenue Stamps

Regulations for printed illustrations of United States and foreign revenue stamps are the same as for postage stamps, except colored illustrations of United States revenue stamps are not permitted.

Coins

Photographs or printed illustrations, motion-picture film or slides of the United States and foreign coins may be used for any purpose.

With few exceptions, existing law generally prohibits the manufacture, sale or use of any token, disk, or device in the likeness or similitude of any coins of the United States or of any foreign country that are issued as money.

Title 18, U.S. Code, Section 481

Whoever, except by lawful authority as described in the foregoing, prints photographs, or makes, executes, or sells any engraving, photograph, print, or impression in the likeness of any genuine note, bond, obligation, or other security, or any part thereof, of any foreign government, bank, or corporation, shall be fined not more than $5,000 or imprisoned not more than 5 years, or both.

Destruction of Prints and Negatives

The negatives and prints of any United States obligation or foreign obligations produced for any of the purposes mentioned previously in this chapter must be destroyed after their final use.

COPY EQUIPMENT

The amount and type of copy work performed in an imaging facility should be the basis for the types of copy equipment on hand. When expensive equipment is not justified or available, a 35mm camera and the sun can be used for copying; however, the best results are obtained when cameras and equipment designed for copying are used.

Copying with a 35mm Camera

When making slides or only when an occasional copy job is requested, a 35mm camera should be used. Copy stands are available for use with 35mm cameras. (fig. 8-2) A set of lights may be mounted on the stand. When lights



302.180X

Figure 8-2.–Copy Stand.

are not provided with the copy stand, regular studio lights can be used in their place.

When a copy stand is not available for use with a 35mm camera, the camera can be used on a tripod, mounted for either horizontal or vertical copying. For vertical copying, the tripod elevator post is removed and inserted into the tripod upside down. The camera is then mounted under the tripod, and the tripod is then centered over the original to be copied.

Cameras for Copying Large Originals

When the copy work done in your lab is considerable and includes many large originals, the type of copy setup used by the graphic arts shops may be needed.

The type of camera used in graphic arts photography is called a process camera. Although larger than other types of cameras, it is similar in principle. Since the process camera is built for copying, it has a copyboard and other features not associated with the average camera. There are two types of process cameras: horizontal and vertical.

Most horizontal process cameras are known as darkroom cameras because the camera back is built into the darkroom wall. Because the back of the camera extends into the darkroom and the front is housed in a separate room, you can load the film, focus the camera, make the exposure, and develop the film without leaving the darkroom. Of course, it is necessary for you or a helper to go outside to place copy in the copyboard before the exposure is made.

In recent years, vertical process cameras have become more popular because they take up much less floor space. This makes them especially useful aboard ship.

CAMERA ADJUSTMENTS.–Each copy camera has slightly different adjustments. You should consult the operating manual of your copy system to learn the proper operation and controls of your particular system. Only the minimum basic components of a copy system are discussed in this chapter.

GROUND GLASS FOCUSING.–Ground glass focusing is essential for exacting copy work The image of a document viewed on the ground glass of a copy camera provides a means of monitoring all aspects of the image as it will appear in the reproduction. This includes image placement, image size, and any apparent unwanted reflections.

BELLOWS EXTENSION.–A copy camera should be capable of a bellows extension of at least two, and preferably three times or more the focal length of the lens being used. With a 3-inch lens and a bellows extension of two focal lengths (6 inches) and the original is positioned four focal lengths (12 inches) from the film plane, a 1:1 ratio of the original size to reproduction size is obtained. A reproduction with a 1:1 ratio can be referred to as "life size." A bellows extension that is less than two focal lengths cannot produce an image as large or larger than the original. A bellows that can be extended more than two focal lengths can produce an image larger than the original.

LENSES FOR COPYING

A primary requirement for a lens used for copying is that it must focus sharply across a flat plan; that is, it must produce a sharp image over its entire field of view-all the way out to the edges of the image. In copying, the original has only two dimensions, and the loss of definition at the edges of the image is much more serious than it would be when photographing a three-dimensional subject.

Regular camera lenses of good quality can produce fair to good copy negatives. But most lenses for general photography are designed to focus at a flat field for distances greater than eight times the focal length. Since most copy work is done at close distances, the image field is not sharp because of the curvature of the general lens. This effect can be compensated for by stopping down the lens. However, because of the high degree of diffraction at small apertures, stopping down reduces the overall sharpness of the image. For critical copy work, such as when copying large, detailed originals, a lens designed for copying should be used. Such lenses, called process lenses, produce the best image at a lens-to-subject distance of about 10 feet or less.

Another very important aspect of a process lens is its evenness of illumination across the focal plane. Evenness of illumination across the entire negative is particularly important when copying line originals. The high-contrast films used to copy line originals have a short exposure latitude and any falloff in illumination results in obvious variations in exposure between the edges and the center of the negative.

For each lens there is an optimum aperture at which the lens produces the best image definition. For copy work, this optimum aperture should be used whenever possible. Since originals to be copied are flat or almost flat, an increase in depth of field by stopping down from the optimum aperture is not required or desired. With some lenses, especially process lenses, the optimum aperture and maximum aperture are the same. Generally, however, the optimum aperture is two full f/stops smaller than the maximum f/stop.

Most process lenses available today are apochromatic. They are designed to be free of chromatic aberrations; that is, they focus sharply all three primary colors in the same plane. Apochromatic lenses must be used for critical work in color copying and duplication.

Since exposure times in copy work are relatively long (i.e., seconds as compared to hundredths of a second), a lens equipped with a means of holding the shutter open is required. Your copy system must be completely free of vibration to obtain sharp images. For these long exposures, you must use the T and B settings and a cable release.

The focal length of a lens used for copying should be governed primarily by the size of the negative to be produced. For example, the focal length should be about equal to the diagonal measurement of the negative to be made. Therefore, when you are making 35mm negatives, use about a 1 3/4-inch or 45mm lens; a 4.5 x 6cm negatives, use a 3-inch or 75mm lens; and for 4 x 5 negatives, use a 6 1/4-inch or 160mm lens; and so on. In any case, you should use a lens that is longer than the film diagonal rather than a lens that is shorter. This way, you are taking advantage of the flatter field that is produced in the center area of the circle of illumination. A macro lens should be used when available because it is designed to produce sharp images at close planes.

COPYBOARD

Copyboards are an integral part of a copy system. The function of a copyboard is to hold the original flat and perfectly parallel to the lens and camera back When the copyboard is not parallel, distortion results, and it

becomes difficult to get the entire subject in sharp focus. In some cases, the copyboard of the camera is a bed with a hinged glass cover. 'The original to be copied is placed on the bed and the glass cover is closed When the cover is closed, the bed squeezes the original against the glass cover to flatten and hold it in place.

Reference lines are generally marked on the felt or rubber surface of the copyboard to aid in centering and aligning the cow. When the copyboard does not have these lines, draw your own on the copyboard or on a piece of paper and fasten it to the copyboard.

Some copyboards have a vacuum pump that provides suction to hold the copy flat to the copyboard. This eliminates the need for a glass cover. After the copy is placed on the copyboard, the pump is turned on and the vacuum holds the original in place.

When the copyboard does not have a vacuum pump or glass cover, originals can be held in place with pushpins. When it is not permissible to put holes in the edges of the original, then double-sided tape may be an alternative. When the copyboard is made of steel, the original can be held in place with bar magnets.

When a camera is not equipped with a copyboard and for occasional work, a copyboard can be made from a sheet of softwood or cork. The surface should be painted flat black, never white. A white, or even light-colored copyboard, reflects too much light into the camera lens, causing flare and troublesome reflections. Flare causes a loss in contrast and extra compression of the shadows. A black copyboard minimizes flare.

Always keep the glass of a copyboard clean. Dust it with a clean camel-hair brush and clean it with a soft cloth and glass cleaner. Never use dirty rags or razor blades to clean the glass. They may scratch it. When you have to scrape the glass, use your fingernail or an orange stick.

LIGHTING EQUIPMENT

Almost any type of light can be used for copy work, provided the intensity of the light is enough to prevent excessively long exposures. Another principle requirement of the light source is to produce a light with a color temperature suitable for the type of film being used.

Tungsten Lamps

Tungsten lamps 3200 K and 3400 K are suitable for normal black-and-white copy work When a reflector type of bulb is used, the need for external reflectors is eliminated. A lens shade should be used with a reflector type of bulb because the built-in reflector does not extend the full length of the bulb, and stray light may reach the lens and cause flare.

Lamps such as 3400 K are not as economical to use as 3200 K lamps because of their short life (4 to 6 hours).

Fluorescent Lights

When fluorescent tubes are used to light an original, they should be arranged to form a square-the sides of which are parallel to the edges of the copyboard. The size of the tubes and their distance from the copyboard are governed by the size of the original to be copied. Because this type of lighting setup is not easy to adjust, it is best used when the size of the originals to be copied does not vary much from one to another. Because of its diffused nature, fluorescent lighting is suitable for copying originals with a textured surface that must be eliminated in the finished print. Regular fluorescent lights should not be used when shooting color film because it is difficult to color correct them accurately. Special fluorescent lamps with a high color-rendering index (CRI) should be used whenever possible. When ordinary fluorescent lamps are used, consult the *Photo-Lab-Index* to determine what filter should be used as a starting point for the type of film you are using.

Electronic Flash

When used properly, electronic flash units are an excellent light source for copy photography. An electronic flash unit allows for extremely short exposures that can be helpful for shipboard photolabs when the ship is underway. The flash unit is balanced for daylight color film and does not produce the heat associated with tungsten or quartz bulbs.

Unless specifically designed for copy work and attached to the copyboard, electronic flash lamps may be difficult to position for proper illumination of the original. The task can be made easier if you use studio electronic flash units with built-in tungsten modeling lights. With this type of lighting unit, the modeling light can be used to position the lights accurately for even illumination of the original. Even with this, the light may have to be heavily diffused to prevent "hot spots." A hot spot is a surface area that receives too much light, causing an unwanted reflection that is noticeable in the final copy product.

Quartz-Iodine Lamps

The quartz-iodine lamps (tungsten-halogen) are of the incandescent variety but bear little resemblance to conventional light bulbs. A quartz lamp is a short tube of quartz glass, housing a coiled filament that runs the length of the tube. In ordinary tungsten lamps, the tungsten evaporates from the filament and settles on the glass and gradually darkens the bulb. In the quartz-iodine lamp, however, iodine vapor combines chemically with the tungsten and causes it to redeposit on the filament. This prevents the tube from becoming tarnished with age. The intensity and color temperature of the tube remain almost constant throughout its life. Although the quartz-iodine lamp is very small, it produces intense light that is particularly suited for copy work. There is a disadvantage-quartz-iodine lamps generate extreme heat that could cause your original to curl. You should never touch a quartz-iodine lamp with your fingers. The oil from your hands can create a concentrated hot spot on the lamp, causing it to bubble and burn out.

LAMP REPLACEMENT.–As lamps get older, their color characteristics and light intensity may change. Therefore, when one lamp in a set bums out, the new replacement lamp is usually brighter and has a different color temperature than the remaining lamps. You should replace all the lamps, not just one to avoid the need for adjusting the new lamp to get even illumination. Replacement of all lamps in a set is particularly important when you are copying with color film because the color temperature of the new lamps is higher than the old lamps. The variation in color temperature would be seen as an uneven color quality over the resulting reproduction.

VOLTAGE VARIATIONS.–Fluctuations in the voltage or electric current affect the color temperature of copy lights. When the voltage to your copy lights varies, consult an electrician. The electrician can trace the source of fluctuation and recommend the best action to overcome the problem.

Parabolic Reflectors

An important element of the lighting equipment for copy work is the reflectors. Parabolic reflectors should cause the light to be evenly distributed over the surface area of the original and not cause hot spots. Certain types of lights, such as reflector photoflood lamps, have built-in reflectors. By use of the correct reflectors with artificial light sources, exposure times can be shortened.

Daylight

Daylight can be another excellent source of illumination for copying. When the sun is used, you should try to use the sun during the midday hours where a combination of daylight and skylight is present, because of the shifting of color temperature throughout the day. The early morning and evening hours should be avoided when color film is used, because the lack of blue light present. Heavy overcast skys or copying in shadow produces a bluish cast and should be avoided or corrected with a filter.

Filters

The use of filters was fully discussed in chapter 3. Both correction and contrast filters, as well as special filters, are used extensively in copy work

FILMS FOR COPYING

For copying, you can achieve the best results by selecting the correct film for the type of copy work to be done. Copy-type films are designed specifically to compensate for the compression that occurs in tone reproduction and it provides an improved highlight tonal separation. Copy films are available only in 70mm and sheet film formats. Although 35mm film can provide acceptable results, you should use sheet film since it provides higher-quality enlargements and is easier to retouch.

Film characteristics, such as color sensitivity and contrast, are important when you select the film to copy a specific type of original. Film characteristics were discussed in chapter 2.

SELECTING THE PROPER FILM

The following factors should be considered when choosing the proper film:

- The color of the original to be copied
- The contrast of the original
- The contrast of the film
- The type of product to be produced, that is, black-and-white or color print, duplicate negative, color or black-and-white transparency, and so on
- Color quality of the light source
- Types of film available

- Color sensitivity of the film
- Filters available

Black-and-White Line Originals

A black-and-white line original has no middle or intermediate tones between the lines and background. Therefore, the best film for copying black-and-white line originals is one with extreme contrast, such as Kodak Kodalith film. These films produce high contrast and extremely high density with an absence of fog, which ensures clear lines on a dense background.

Kodalith type of films have a very limited exposure latitude, and therefore, must be given very accurate exposure. Underexposure produces low-contrast negatives that result in prints having a muddy gray background instead of a clear, crisp, white background. Overexposure causes weak or very fine lines to fill in and results in a less than perfect transparency of the lines on the negative.

Typewritten material should be included in this type of original. When an original is typed or printed on thin white paper and on one side only, you should place another sheet of white paper behind the original to copy it. This increases the reflective ability of the original and increases contrast. When the original is printed or typed on both sides of thin white paper, place black paper behind the original to help prevent the printing or type on the reverse side of the original from showing through.

Colored Line Originals

In copying colored line originals to a black-and-white reproduction, you must maintain the high contrast between the lines and the background. This is best achieved by using a high-contrast panchromatic film, such as Kodak Contrast Process Pan film and a filter. When the lines or subject is to be rendered light against a dark background, the filter should transmit the color of the subject and absorb the color of the background. When the subject is to be rendered dark against a light background, the filter should absorb the color of the subject and pass the color of the background.

For example, a blueprint has white lines on a blue background. Copying the blueprint with Kodalith Pan film without a filter cannot produce maximum contrast because the film is highly sensitive to blue light and thus records the image of the blue background as a midtone of gray while recording the white line image as a dense highlight. When a red filter is used, the white lines still record as a dense highlight on the negative, but now the blue background records as a shadow area because the red filter absorbs the blue light reflected from the blue background. Thus the background reproduces darker when a red filter is used.

Black-and-White Continuous-Tone Originals

To reproduce the tone gradation of a continuous-tone original, you must use a long-scale film. As discussed previously, a commercial type of film, such as Kodak Commercial film, is recommended.

The common fault in continuous-tone original copying is underexposure and overdevelopment. Full exposure with restrained development is the best rule for this type of work

Although appearing as line originals, handwritten material, pencil drawings, and so forth, are actually continuous-tone originals because of the midtones they contain. These should be copied as continuous-tone originals. Films, such as Kodak Professional Copy film or Kodak Commercial film, are recommended.

Colored Originals

When a black-and-white reproduction of multicolored reflection originals, such as color photographs, oil paintings, and so forth, is to be made, it should be copied with a moderate contrast, panchromatic film capable of recording numerous shades of gray. Panchromatic, long-scale film is recommended for copying this type of color original.

Colored originals are almost limitless in their degree of difference because of all the possible colors and hues. Each different colored original should be copied on the basis of what is desired in the black-and-white reproduction.

Color Reproduction of Color Originals

Selecting a film for copying colored reflection originals to make color reproductions is a matter of what type of reproduction is needed-reflection or transparency. Films, such as Kodak Vericolor III Professional Film Type L and Type S and Vericolor Internegative Film, can be used to produce color reflection copies. Color transparency film must be used to produce color transparencies from reflection originals. Some films have a different recommended ISO rating when used with tungsten or daylight light sources. Be sure to consult the data sheet supplied with the film or the *Photo-Lab Index* to determine the proper ISO setting.

When you are copying a color print to a color negative, the best film to use is Kodak Internegative film. Because of the inherent high contrast of photographic papers, if not controlled, contrast is gained in each generation of a reproduction. Kodak Internegative film is designed to give greater contrast separation in the highlights without raising the overall subject contrast in the negative. To achieve proper color balance in the shadows, midtones, and highlights, you must perform tests to assure that proper exposure and color filtration is obtained. The *Photo-Lab Index* contains the procedures necessary to accomplish this testing.

Combined Black-and-White Line and Continuous-Tone Originals

When a black-and-white original contains both line and continuous-tone matter, the ideal copy method is to copy each type of matter with an appropriate film separately and then sandwich the two negatives together, or print the two negatives separately on the same piece of paper. The colored lines should be copied with an extremely high contrast film, such as Kodalith Pan, and the pastel-colored portions of the original should be copied with a moderate contrast film.

When copying the original with only one type of film, you loose quality in either the lines or the continuous tones. For best results, you should copy the combined line and continuous-tone original with a moderate contrast film, such as Kodak Professional Copy film or Kodak Commercial film.

Black-and-White Halftone Originals

A black-and-white halftone original consists of a pattern of black dots of various sizes that represent tones of gray. Examples of halftone originals are printed pictures in newspapers or magazines. Small dots with ample white space between them produce an illusion of a light tone or highlight. Large dots that are close together produce the illusion of dark tones or shadow areas. Because the dots are all the same tone (black), halftone originals can be copied as line originals. This type of original can also be copied as a continuous-tone original, depending on the use of the final product.

Reflection Originals Specifically Produced for Copying

When an original is to be used specifically for copying, you can take certain measures to ensure better reproduction results.

PHOTOGRAPHIC PRINTS.–Black-and-white and color prints produced for copying should have normal density, color saturation, and a glossy surface. When a non-glossy surface is used, the texture of the surface may be apparent in the copy negative and reproductions.

TYPEWRITTEN MATERIAL.–Typewritten material that is to be copied should be typed with a new typewriter ribbon. A carbon "one time" ribbon is best. To further increase contrast between the type and the paper background, you can place a sheet of carbon paper behind the typing paper. This causes the carbon to be transferred onto the back of the paper during typing.

When using a typewriter to produce copy that will be photographed for making 35mm slides, limit your typing to no more than 8 double-spaced lines with 43 elite or 36 pica characters to a line. When photographing typed copy, use a template as a guide for setting up your camera Allow about 1/8 inch of space outside the template lines in the camera viewfinder.

Originals with Defects

Occasionally, the only record of an event is the original document that through age or use is no longer in its original condition. By use of appropriate corrective measures, certain defects in originals can be eliminated or minimized in the reproduction.

WRINKLED OR CREASED ORIGINALS.–Reflection originals that are wrinkled or creased can be flattened by placing the original on a mounting board and then in a heated dry-mounting press. Mounting in this manner is permanent and should be considered carefully before being used.

Another method you can use to flatten an old photograph is to wet the photograph with water and squeegee it onto a sheet of glass with the emulsion toward the glass. The photograph must be removed from the glass before it dries; otherwise, it may stick to the glass.

STAINED BLACK-AND-WHITE ORIGINALS.–Usually, transparent stains on black-and-white originals can be eliminated in the reproduction by using panchromatic film and a filter that is the same color as the stain. Details on eliminating images of stains with filters is discussed in chapter 3.

FADED BLACK-AND-WHITE PHOTOGRAPHS AND MANUSCRIPTS.– Normally, black-and-white photographs and other types of original documents that have faded and are yellowed should be

copied with a film, such as Kodak Commercial film. An original with a weak, faded image should be copied with a film, such as Kodak Contrast Process Ortho.

SPECIAL APPLICATIONS IN COPYING

Special applications are used in copying to detect information that cannot be seen with our eyes under normal lighting conditions. Because these are special applications, they are not performed in most Navy imaging facilities, but are still worth mentioning. These methods involve the use of infrared and ultraviolet radiation and special types of films.

Black-and-White Infrared

Copying with black-and-white infrared films and infrared radiation can help in deciphering old, charred, or altered documents. This is possible because similar appearing materials can reflect and transmit invisible infrared radiation in different amounts. For example, two ink signatures may appear identical to the eye. However, when photographed with an infrared film, the two signatures may appear totally different.

A suitable infrared filter must be used when black-and-white infrared films are exposed. This is because infrared film is sensitive to visible light as well as infrared radiation. The infrared filter absorbs the visible light so the film image is produced entirely with infrared radiation. For specific filter recommendations, consult the data supplied with the film or the *Photo-Lab Index.*

Infrared wavelengths are longer than visible light wavelengths and do not focus on the same plane as visible light. Therefore, a slight increase in lens-to-film distance is necessary. A separate focusing scale for infrared is indicated on the focusing scale of most lenses.

Ultraviolet Radiation

Copying with ultraviolet (UV) radiation can aid in detecting chemically erased or badly faded writing and restoration or alteration of artwork because different materials reflect or fluoresce different amounts of ultraviolet radiation.

Photographing with reflected ultraviolet radiation in total darkness is possible because some of the ultraviolet absorbed by a material may be overlooked as visible light or fluorescence. Such photography in darkness is possible only when a material is illuminated with an ultraviolet source, such as the General Electric Uviarc. The fluorescence from a material illuminated with ultraviolet radiation should be photographed with a No. 2A (pale yellow) filter to absorb the stronger UV reflections. A recommended film to use for ultraviolet photography is Kodak Contrast Process Ortho film. Exposure tests should be conducted to determine the best exposure for an ultraviolet copy setup.

Do not use commercial ultraviolet lamps in which the lamp itself is an ultraviolet filter. These lamps transmit visible light that does not permit photographing a fluorescing original.

COPYING REFLECTION ORIGINALS

Reflection originals are documents or other flat objects like pictures or drawings that are viewed and photographed (copied) by reflected light.

Copying reflection originals can be done with either horizontal or vertical copy cameras or setups. The size of the copy setup can range from the space necessary to attach the original to a wall and make the copy photo with a tripod-mounted camera, to a copy setup which fills two rooms- one containing the camera back and darkroom and the other the copyboard. Regardless of the different copy setups possible for reflection originals, the copying techniques are the same with few exceptions. In general, the procedures used for copy work are placing the original on the copyboard, aligning the optical axis of the lens with the original, lighting the original, focusing the lens, calculating the exposure, and exposing the film.

PLACING THE ORIGINAL ON THE COPYBOARD

A copyboard should have a positive means of attaching and holding the original. The means of attaching the original could be spring clips, small bar magnets, thumbtacks or pushpins, a hinged glass frame, a sheet of glass, vacuum, and so forth. When thumbtacks or pushpins are used, be sure not to punch holes in the original. For high volume copy, a vacuum copyboard allows a more rapid change and positioning of originals on the copyboard.

When you are using a vertical copy camera or setup, a darkroom printing easel may be used to hold the original in place.

ALIGNING THE OPTICAL AXIS OF THE LENS WITH THE ORIGINAL

Arising, falling, and sliding front feature of a copy camera provides for the alignment of the lens and the

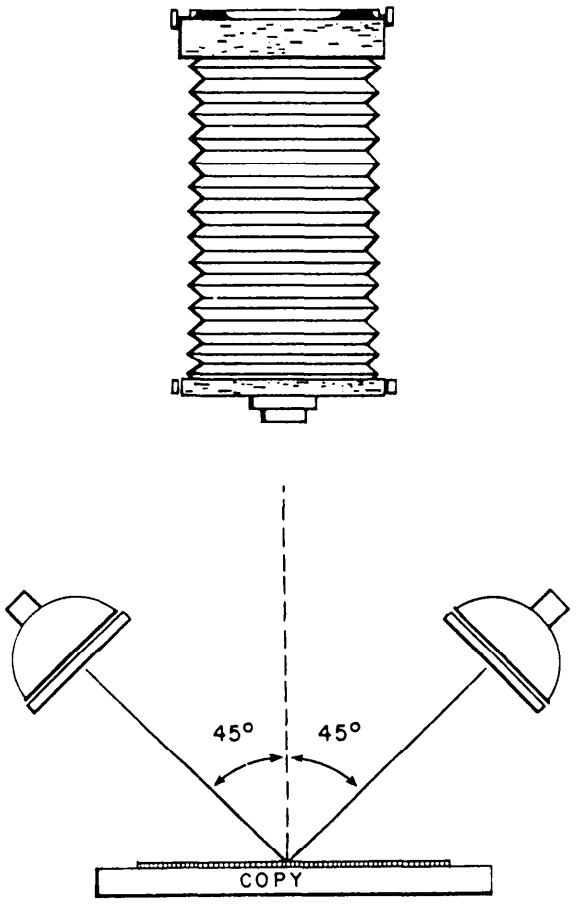


Figure 8-3.–Lights positioned at a 45-degree angle.

original without moving the camera or the original. When the camera is not designed with a rising, falling, and sliding front, the camera or original must be moved to align the original with the optical axis of the lens.

LIGHTING THE ORIGINAL

One of the most important elements in copying is proper, even illumination of the original. Originals that are not properly and evenly lighted yield negatives with uneven density, which are hard to print. This is true whether the original is illuminated by daylight or artificial light. Uneven illumination can be caused by improper placement of artificial lights in relation to the copyboard or by improper placement of the original in daylight.

Artificial lights are normally placed on two sides of the copyboard. A 45-degree angle is recommended for general use (fig. 8-3). At this angle, a minimum of unwanted reflections from the surface of the original occurs. However, depending on the type of surface of the original, the best angle for the lights may change. For example, an original artwork may have brush strokes that produce reflections. These reflections may be reduced somewhat by placing the lights at an angle greater or lesser than 45-degrees.

Do not position artificial lights too close to the copyboard. The circles of illumination will not cover the original completely. Movable lights should not be positioned so far from the copyboard that the intensity of the illumination falling on the original is greatly reduced.

The evenness of illumination on an original can be checked with an exposure meter. Do this by placing a gray card on the original and taking a reflected light meter reading from the card. Do not allow the shadow of the meter or your hand to influence the reading. When a gray card is not available, a white card (the back of a sheet of photo paper) can be used, but you must compensate your exposure by two f/stops. Reflected light from the four corners and center area of the original should read the same light values.

Daylight provides two choices of illumination: direct sunlight and diffused daylight, such as a cloudy, bright day or open shade. Evenness of daylight illumination is controlled by ensuring that the original is completely in direct sunlight or in diffused daylight, and no shadows are cast on the original.

Although an original is uniformly illuminated over its entire surface, apparent unevenness in illumination may still appear in the copy if a wide-angle lens is used. This is caused when the light transmitted through the center of the lens is more intense than the light transmitted near the edges of the lens. When the entire angle of view of the wide-angle lens must be used, more illumination to the edges of the original is needed to compensate for the falloff of light at the edges of the lens. This can be achieved by turning the lights slightly toward the edges or by moving the lights close to the edges. The amount of light increase necessary for the edges of the original is best determined by conducting exposure tests with the type of film being used.

Lighting control is more critical when using an extremely high contrast film, compared to a high, moderate, normal, or low contrast film. Uneven lighting is more visible in a copy produced with an extremely high contrast film because of the limited exposure latitude of the emulsion.

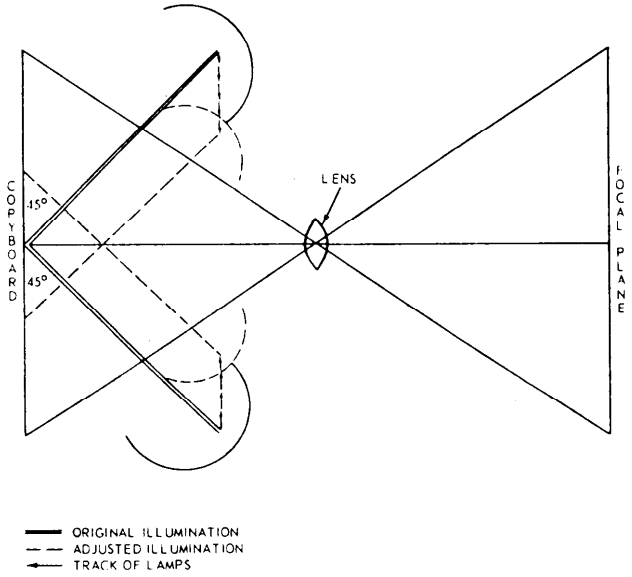


Figure 8-4.–Lighting large originals.

Kelvin Temperature of Illumination

When you are producing color copies, the Kelvin temperature (color) of the light source should match the color balance of the color film being used. When a light source produces an illumination color other than that for which a color film is balanced, filters must be used to alter the Kelvin temperature of the illumination to correspond with the color balance of the film.

Rises and drops in voltage also affect the color temperature and intensity of illumination. Fluctuation in voltage can be controlled by using a voltage regulator.

Lighting Large Originals

For most copy work, you should position the lights at a 45-degree angle, about 36 inches from the copyboard, and aimed at the center of the original. However, there are occasions when you may have to copy a large chart, and the normal lighting setup causes uneven illumination. Light from an artificial source must travel farther to reach the center of the original, and the light reflected from the edges must travel farther to reach the lens. This causes the light to be less intense along the edges and may result in underexposure of these areas. You can correct this condition by adjusting the lights. Keep the lights at a 45-degree angle, but move them closer to the lens optical axis until the light beams from the lamps intersect in front of the original (fig. 8-4). Balance is generally achieved when the beams cross each other at a point approximately one third of the distance from the copyboard to the lens. Check the lighting on the ground glass or through the viewfinder to see whether it is even from the center to the outer edges.

When lighting large copy, the use of portrait lights with umbrellas is a good source of illumination. The wide coverage and diffused light, produced from this light source, allows you to light the original easily and evenly. To check the evenness of the lighting, use a flash meter and take readings from the center, corners, and intermediate points on the original.

Reflection Control

Unwanted reflections often affect copying. Proper placement of the lights is generally sufficient to eliminate most normal reflections. The three types of unwanted reflections in copy work are as follows:

- Reflections from the light source
- Reflections over the entire surface of the original or copyboard
- Optical flare

Reflections from the light source are caused by light reflecting from the camera stand, lens board, cable release, or other shiny objects around the copy setup. The reflections usually occur when you are copying glass-covered originals, glossy photographs, or other smooth-surfaced originals. The best way to eliminate this type of reflection (when changing the position of the lights does not help) is to use a black cloth or a sheet of cardboard (painted dull black) as a shield between the lens and copyboard. You can do this by cutting a hole the size of the lens in the center of the cloth or board then placing the cloth or board over or around the lens. A lens hood also helps in reducing or eliminating this type of reflection.

Reflections over the entire surface of an original can occur with rough, scratched, crumpled prints or paintings with brush marks, canvas texture, cracks, and so forth. These reflections are caused by high spots on the surface of the original and cause small light reflections of the light source. Such small reflections cover the surface of the original with a haze of light that results in a low-contrast copy image. Reflections of this type are more difficult to avoid than reflections of the light source. As long as the lights shine directly on the rough surface, such reflections occur no matter in what position the lights are placed. There are two lighting methods by which this type of reflection can be minimized or eliminated. These methods are bounce lighting and polarized lighting.

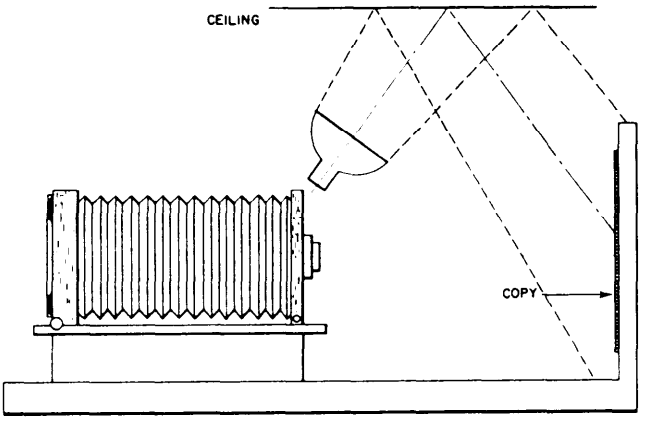


Figure 8-5.–Using bounce light to control reflections.

BOUNCE LIGHTING.–When a white surface is low enough, you should direct the light sources upward so diffused light bounces off the surface onto the original (fig. 8-5). When the surface is too high or other than white, it may be possible to use a white reflector positioned horizontally over the upturned lights. This reflector could be a large sheet of white cardboard.

POLARIZED LIGHTING.–The most efficient method of eliminating unwanted reflections in copy work is by using polarized light. In regular photography, a polarizing filter is placed over the camera lens to subdue reflections. This works because the light from the sun is polarized as it passes through the atmosphere and is reflected by the object being photographed. Using a polarizing filter over the lens only does not greatly reduce unwanted reflections in copy work. In copying, polarizing screens must be used over the lights as well as a polarizing filter over the lens.

When polarized light is used in copying, a considerable increase in exposure is required. This exposure increase is from about 10 to 16 times the normal exposure required with the same lights without polarizing screens. The exact increase is best determined through a series of exposure tests.

Reflections caused by flare are common with dirty or poor quality lenses. When available, lenses designed for copy work should be used, and like all lenses, they should always be kept clean.

DETERMINING EXPOSURE

Like all other types of photography, in copying there are various factors that must be considered when calculating exposure. You must consider the nature of the original-its color and brightness, the intensity of the light source, the film speed, the filter factor, and the object-to-image ratio or bellows extension

Color and Brightness

Light-shaded or light-toned originals reflect more light than dark originals. Thus, with the same lighting setup, dark originals require more exposure than light originals. The amount of exposure compensation depends on the darkness or lightness of the original. When TTL (through the lens) metering is read directly from the original, a dark original may require twice the exposure of a standard exposure, and a light original may require less than 50 percent of a standard exposure. You should always use a gray or white card to determine the exposure more accurately.

Intensity of Illumination

Intensity of illumination at the copyboard can be controlled by placing the lamps closer or farther from the copyboard, by using lamps of different light intensity output, or by reducing the intensity of illumination by diffusing the light.

The best method for measuring illumination intensity at the copyboard is with an exposure meter. An exposure meter is particularly useful when the copy lights are moved or changed from the positions used to calculate a standard exposure.

The recommended ISO film speeds or exposure indices of copy films apply directly when an incident meter is used or when a reflected meter reading is taken of an 18 percent gray card at the copyboard. When a gray card is not available, a reflected meter reading of a matte white surface with about 90 percent reflectance can be taken. The back of white photo paper provides this reflectance. When a white surface is used to calculate an exposure, the ISO or exposure index of the film should be divided by 5 and rounded off to the nearest setting on the meter. For example: when the ISO is 32, divide by 5 and use 6 or the nearest setting on the meter. You also may take the meter reading directly without changing the ISO and increase the exposure by two f/stops. Remember, exposure meters are calibrated to produce middle gray regardless of the light reflectance ability of the subject. Thus the light reflectance ability of an original should be considered in determining an exposure.

The *exposure indices,* given for high contrast materials used in line copy work, are intended for trial exposures, even when an exposure meter is used.

Exposure Compensation for Bellows Extension

As discussed in chapter 4, an exposure calculated with an exposure meter is precise only for a lens set at a distance equal to one focal length When the distance between the optical center of the lens and the focal plane is greater than one focal length, an increase to the indicated exposure is usually required. Before an accurate increase in exposure can be applied by opening the lens diaphragm, the effectiveness of the f/stop of the indicated exposure should be determined Remember, the marked f/stops of a lens that is set beyond one focal length are not valid because the f/stops are a ratio of the diameter of the lens aperture to one focal length. Refer to chapter 4 to determine how to compensate exposure for bellows extension.

PROCESSING COPY FILMS

Films used for copying are processed the same as any other film. They can be processed by machine or by hand, using tanks or trays. Recommendations for specific developers, developing times, and developing temperatures are given with each type of film. Some films not designed specifically for copying may yield negatives with excessive contrast. This can usually be avoided by reducing the developing time. Consult the *Photo-Lab Index* to find suitable developing times to lower or raise contrast.

CATHODE-RAY TUBES

Although taking photographic images from cathode-ray tubes (CRT) is not actually a type of copy work, it has become more commonplace to photograph their images for briefs and presentations. Televisions, computer monitors, and radarscopes all can be classified as CRT photography.

When you are shooting CRTs, like all copy photography, it is important for the optical axis of the lens to be centered and perpendicular to the monitor. The camera must be mounted on a sturdy tripod. A cable release and a macro lens are recommended.

When you are photographing radarscopes, time or shutter speed is not a factor of exposure. The number of sweeps on the scope is the factor that determines the exposure at a given f/stop. The number of rotations is not proportional to film exposure. As a general rule, the exposure doubles between one and three sweeps. To get the correct exposure, you must bracket the exposure. A good starting point for less than three sweeps with ISO 125 film is at f/5.6.

To get the sharpest and clearest image possible, you must adjust the brightness of the radarscope correctly. Do this by turning up the intensity until halos appear. Then turn it down until the halos just disappear. When the intensity of the scope is too great, the image appears out of focus. If the intensity of the scope is not great enough, there is little contrast between the video and the background.

Computer-generated graphics are a common means of producing material for use in slide briefings. When available, use a computer monitor with a flat screen rather than a curved screen Use the same procedures for shooting computer screens that you use for radarscopes. The difference is there is no sweeping motion when shooting a computer monitor or a television. When motion is apparent, you must use a shutter speed of 1/30th of a second. When you use this shutter speed, the film records the image without obvious scan lines and stops the motion of the image.

When photographing images from a CRT, always darken the room before you make the exposures. This prevents glare on the screen and only the illumination from the screen affects the film.

SLIDE DUPLICATING

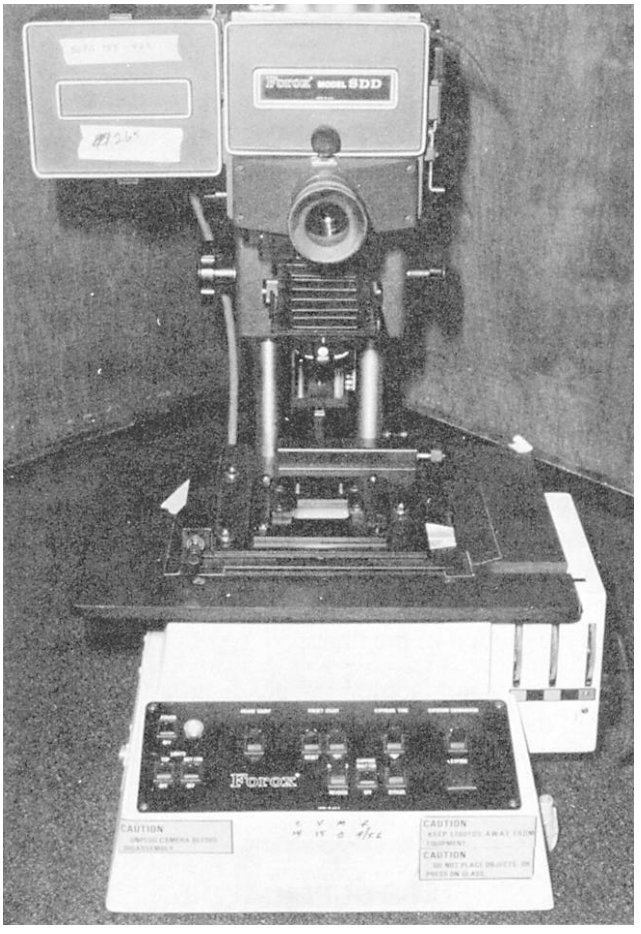
In photography, you must often make duplicate slides from an original. Duplicating is actually a form of copying. A duplicate or “dupe” can be made to almost any desired size. Contrast and density along with color adjustments can be made when duplicating color slides.

Color slides are duped to provide extra copies of the slide, correct color balance and contrast errors, or even to change or enhance colors for special applications.

CAMERAS AND ACCESSORIES FOR DUPLICATING

Except for the copyboard or easel, the features of the equipment used for duplicating transparent originals are essentially the same as that used in copying reflection originals. The exception being that the copyboard for copying transparent originals must allow light to be transmitted through the original to the camera.

Except for being lit by transmitted light, large format transparent originals (larger than 35mm) are copied the same as reflection originals. 35mm transparencies are copied with special slide copying attachments for cameras, or copied in specially designed, semiautomatic or automatic slide copiers.



302.185

Figure 8-6.–Slide duplicating system.

Regardless of the equipment being used, your goals for duplicating transparent originals should be to duplicate, improve, or alter, as desired, the reproduction of the original.

DUPLICATING 35mm COLOR SLIDES

To get additional copies of a color slide, you must either make several exposures of the original scene or make duplicates from the original slide. When the scene cannot be re-photographed, the only alternative is to make duplicates of the original slide.

Other than making a number of duplicate slides from an original, you can use the duplicating process to improve a photograph. The image can be made larger or smaller, the composition can be changed through cropping, the density of the duplicates can be changed from the original, and with the use of filters, the color of the reproductions can be changed.

In most Navy imaging facilities a camera designed especially for copying slides is used (fig. 8-6). This camera setup usually consists of a unit having a camera body and lens, bellows extension, light source, a copyboard, filter holders, and the necessary controls and switches. When slides are copied with a slide duplicating camera, the slide is transilluminated. This is the most common method of copying slides.

Exposure

Whatever method you use to copy slides, you must make exposure tests. The original slide you choose to make the tests should have average density and brightness and normal contrast. This slide should be retained as a reference slide. A full-frame slide of a color rendition chart (color checker) serves ideally as a reference slide. A color rendition chart allows you to visually or objectively compare a series of colors and densities of the original reference slide against the slide duplicate. To visually compare slides, you should use transmitted light and color viewing filters to judge the slides. The objective method is more accurate. A densitometer is used in this method. A densitometer is an electronic meter that measures the actual density of black-and-white and color materials.

Kodak Ektachrome slide duplicating film is recommended for slide duplication. This film is manufactured to provide lower contrast, less filtration with tungsten lighting, and it has good color reproduction characteristics.

The data supplied with the slide duplicating film or the *Photo-Lab-Index* provides information that you can use as a starting point for exposure tests. However, you should bracket the exposure at least one f/stop in one-half f/stop intervals on each side of the basic exposure.

Slide Handling

The original slide must be clean to produce high-quality duplicate slides. The smallest piece of dust or lint is magnified greatly when the slides are projected. Never touch a slide with your fingers. Handle the slides only by their mounts. Hold unmounted transparencies only by the edges. Dust or lint should be removed with low-pressure air or a camel-hair brush. If there are fingerprints or oily smudges on the slide, you can remove them with a soft, lint free pad or a piece of cotton dampened with film cleaner.

Slides should be placed in the slide duplicator base-side up. When you are duplicating the full frame

of the slide, you must place the slide on the copy stage horizontally, regardless of the composition of the slide. When a full frame view is not desired, you can crop or enlarge a portion of the original slide. When you change the camera or lens distance to alter the image size, be sure to refocus the image.

Examining Results

The duplicate slide should be laid on a light table and compared to the original. If you bracketed your exposure, determine which exposure provides the correct density. When none of the exposures are correct, the original must be recopied and given more or less exposure by changing the f/stop. The exposure time should not be changed. Again, bracket your exposure.

Color Balance

Color compensating (CC) filters are used in a slide duplicating camera. The CC filters are placed between the original and light source. By changing the filtration, you can correct the color balance of the duplicate slides.

After producing a duplicate slide with proper density, the color balance of the duplicate slide must be evaluated. When the color balance is off, you must change it through the use of CC filters and re-shoot the original. When the duplicate is extremely yellow, first check the slide duplicating light source. Most slide copy systems using tungsten light, have a "view setting" and a "filter setting." If the system was set in the view position, the CC filters were not in place. The unfiltered tungsten light produces a slide that is very yellow.

To judge the color balance of the duplicate slide, lay it on a light table, compare it to the original, and determine what color or colors are in excess. To do this, you should view the duplicate slides through various CC filters. A color print viewing kit is convenient for this purpose. When viewing slides through the various filters, look at the midtones, not the shadows or highlights. Color viewing filters are helpful in making color balance determinations. If a color rendition chart was used as the original slide, a densitometer can be used to directly compare the color balance of the original to the duplicate.

To adjust the filter pack for the color in excess in the duplicate slide, you should either subtract filtration of the color in excess or add filtration of the complimentary color to the color in excess. The amount of change required is about the same as the viewing filter required to make the midtones appear correct.

Table 8-1.–Color Compensating Filter Factors

FILTER	FACTOR	FILTER	FACTOR
05Y	1.1	05R	1.2
1OY	1.1	10R	1.3
20Y	1.1	20R	1.5
30Y	1.1	30R	1.7
40Y	1.1	40R	1.9
50Y	1.1	50R	2.2
05M	1.2	05G	1.1
10M	1.3	10G	1.2
20M	1.5	20G	1.3
30M	1.7	30G	1.4
40M	1.9	40G	1.5
50M	2.1	50G	1.7
05C	1.1	05B	1.1
10C	1.2	10B	1.3
20C	1.3	20B	1.6
30C	1.4	30B	2.0
40C	1.5	40B	2.4
50C	1.6	50B	2.9

For example, when a slide is over in blue and requires a CC20 yellow viewing filter to make the midtones appear correct, a CC20 blue filter should be subtracted from the filter pack. When a CC20 blue filter cannot be removed, a CC20 yellow filter should be added to the filter pack Your first choice should **always** be to subtract rather than add.

Adding or subtracting filters has an effect on exposure. To determine the exposure change required, you should refer to the operating instructions for the slide copier or consult a CC/CP filter factor table (table 8-1).

The number of filters used in a filter pack should be kept to a minimum. Do not combine all three filters. This only creates neutral density.

After processing, select the best exposure and use it as the basic exposure for future duplicates. When you copy other slides that are darker or lighter than the reference slide, adjust the basic exposure. Use one-half

or one f/stop more exposures for slides that are darker than the reference slide, and one-half or one f/stop less exposure for slides that are lighter than the reference slide.

You should maintain a log of the different types of copy jobs completed in your area of responsibility. With the continual changes in photographic film, processes, and equipment, you must always perform tests (whether it be standard copy or slide duplication) to achieve the highest quality product possible. Camera distance, light source (K), light distances, film type, filters, camera settings, and processes should all be included in the log. By maintaining a log, you eliminate the necessity for photographic testing every time a routine copy job comes into your work center.

CHAPTER 9

CHEMICAL MIXING

When light-sensitive emulsions are used, photography is essentially a chemical process. You depend upon the chemical process to produce visible and permanent images. An important requirement for optimum photographic processing is the careful and correct preparation of photographic solutions. Improper mixing of chemicals or contamination during mixing can have far-reaching effects on operations, quality, production, and mission accomplishment in the imaging facilities of the Navy. It is often difficult to determine the cause of poor quality when improper chemical mixing is at fault, and the need for discarding incorrectly prepared or contaminated solutions cuts down on production and wastes money.

The main function of the darkroom portion of the photographic process is to develop film and produce prints, and this requires photographic chemistry. It may be your job to ensure that all chemicals needed are mixed and checked for quality. "This is a responsibility that you cannot take lightly." A solution that is mixed improperly may cause an entire mission to be lost. You must use the utmost precautions when mixing, checking, or analyzing the photographic solutions used in your lab.

PHOTOGRAPHIC CHEMICAL AND SOLUTION STORAGE

When you receive chemicals in your imaging facility, the cartons, packages, or containers should be dated to show either the date received or the date shipped. This helps provide proper stock rotation and systematic control of chemical usage. Chemicals should be issued from the storeroom on a first-in-first-out (FIFO) basis.

Unmixed chemicals should be stored in their original, unopened containers in a cool, dry, well-ventilated storage area where the temperature is maintained at or about 75°F with a relative humidity of about 40 percent.

Prepared solutions, like dry chemicals, also must be protected from adverse conditions, especially oxidation and contamination. When the following recommendations are adhered to, most "unused" solutions stay in good condition for a reasonable period of time:

- Small amounts of replenisher and stock solutions are best kept in stoppered or screw-cap bottles. Glass bottles are best for developer and developer replenisher. Screw caps must be free of corrosion, foreign particles, cardboard inserts, and be airtight. Never interchange bottle tops from one bottle to another. A cap-to-bottle color or number code is suggested.

- When large bottles are used to store solutions, the air space in the bottle is increased each time the solution is removed. Since this increases the chance for oxidation, store solutions in small bottles instead. The entire contents of a small bottle can then be used at one time. However, a small air space should be left even in small bottles. This allows for varying solution volume due to temperature changes and keeps the cap from loosening or the bottle from bursting.

- When tanks are used for the storage of large volumes of solutions, they should have floating lids to protect the solutions from aerial oxidation Dust covers also should be used to cover the top of the tank. The tank, the lid, and the cap should be coded in such a way that they are reassembled with the correct parts.

- ،Always follow the storage and capacity recommendations of the manufacturer. They are packaged with the chemicals. Do not use chemicals that have been in storage too long.

- Before you use any solution, no matter how long it has been mixed or in storage, check it for discoloration. Each solution has its own "signature" or characteristic appearance; and any change from normal may be a sign that it will produce unsatisfactory results. Check both sides and the bottom of the tank for precipitates. If there are any, carefully stir the solution to redissolve them. When you are unsure of the quality of the solution, discard it.

Most photo-processing chemical formulations are based on both their photographic qualities and their chemical stability or keeping qualities, both on the shelf before mixing and as prepared solutions. After long-term storage, chemicals may lose some of their chemical activity.

MIXING, TESTING, AND STORING EQUIPMENT

The type of material, used for photographic chemical mixing, solution testing, storing, as well as film-handling equipment, must be considered before mixing chemicals. Materials commonly used in the construction of this equipment are Type 316 stainless steel, polyethylene, and glass. Related equipment, such as solution transfer lines, mixer shafts, impellers, and machine parts, are also made of these same materials.

Some metals are not suitable for use with photo solutions. Serious chemical fog and developer changes can be caused by tin, copper, brass, and bronze. Aluminum, lead, nickel, zinc, galvanized iron, and Monel, when used with developers and fixers, can be harmful to films and papers. When these metals are used, silver thiosulfate from the used fixer may stick to them. Even when the utensils are washed after being in the fixer, enough silver thiosulfate can be transferred to the developer in the next processing or mixing run to cause stain, fog, or changes to image tone.

Wooden paddles and other absorbent materials must not be used with photographic solutions. Once they have been used, it is almost impossible to wash them clean of absorbed chemicals.

MIXING CONTAINERS

Chemicals should always be mixed in cylindrical containers made of suitable materials, The size of the mixing container should be suitable for the amount of solution to be prepared. A small batch of solution should not be mixed in a large vessel that uses mechanical agitation because large amounts of air may be introduced, and splashing may occur. So, the mixing container, and for that matter, scales and graduates, should be sized to the quantities and volumes of solutions required.

GRADUATES

Graduates are used to measure liquids. Graduates are made in various sizes, calibrations, and of various materials. The units of measure of graduates are calibrated in the U.S. liquid measurement system of ounces, quarts, and gallons, and in the metric liquid measurement system of cubic centimeters, milliliters, and liters.

Glass is most commonly used for making graduates because it is NOT affected by most chemicals. Glass is also transparent and reasonably durable. Graduates are also made from plastic and stainless steel. When using graduates made of plastic, do not try to measure strong acids, such as sulfuric acid, which could cause severe damage. You must also be sure that the material the graduate is made of does not react with any of your photographic chemicals.

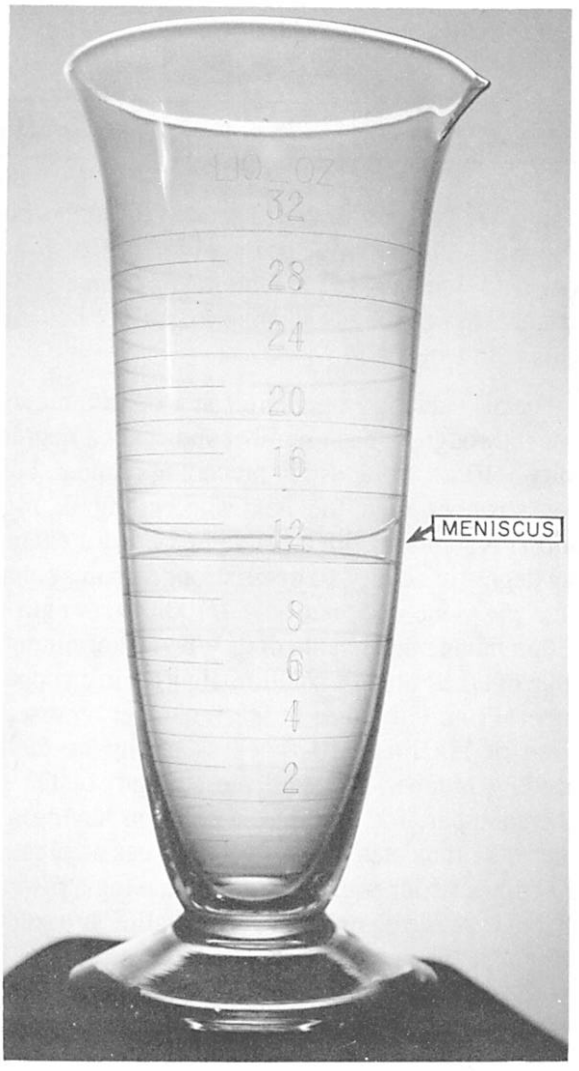
For accuracy in measuring liquids, graduates should be proportional in size to the quantity of solution being measured; for example, an 8-ounce graduate should be used instead of a 32-ounce graduate to measure 2 or 3 ounces.

When measuring a liquid in a glass graduate, hold it at eye level and pour the solution into it until the surface of the liquid reaches the correct mark. You will notice a curved surface on the top of the solution. This curved surface is called the “meniscus.” The correct amount is indicated by the lower of two visible lines of the meniscus (fig. 9-1). These two lines can be seen easily through the side of a glass graduate when it is held correctly. With an opaque graduate, such as stainless steel, the two lines can be seen by looking down into the graduate from an angle. Stop pouring the solution when the “lower line” of the liquid reaches the calibration mark. Major divisions are indicated by numbers on the graduate. Subdivisions are shown by calibration lines only. You must determine the value of the individual subdivisions; for example, the marked or numbered lines may indicate ounces and read in series of 10. When there is only one calibration line between each graduation of 10, then the value of the calibration line is 5.

THERMOMETERS

All chemical action takes place faster at high temperatures than at low temperatures. In the photographic process, when you mix or use a solution, you must know its temperature.

Thermometers are used to measure the temperature of the solution and may be made of glass or metal. The average glass thermometer consists of a bulb, containing either mercury or colored alcohol, attached to a capillary tube. This tube may be calibrated or it may be secured to a graduated scale. When you are reading a



237.223

Figure 9-1.–Read tbe lower line of the meniscus when measuring liquids

thermometer, your eyes should be level with the top of the liquid column in the capillary tube; otherwise, the reading may be off as much as 2 or 3 degrees. This error is due to the refraction of the cylindrical magnifier that is built into the capillary tube.

Most Navy photographic labs have metal, dial type of thermometers made of corrosion-resistant steel. They have a long, thin metal stem, or rod, with a circular dial indicator at the top. The action of this thermometer is remarkably fast, and the dial is easy to read.

The accuracy of all lab thermometers should be checked regularly against one of known accuracy, such as a Kodak process thermometer.

HYDROMETERS

Another measuring device used in photography is the hydrometer. A "hydrometer" is used to determine the specific gravity of a solution. A specific gravity check is one of the first tests to verify the dilution of a solution. When the same chemicals are used and when the same quantity of chemicals and an equal volume of water are used each time, the resulting liquid is approximately the same specific gravity each time. This is a characteristic of that particular solution when all specific gravity measurements are made at the same temperature.

The specific gravity should stay within an upper and a lower limit as determined by the manufacturer for each solution. Variations beyond the upper limit-indicating a denser or heavier liquid-suggest that more than the prescribed amount of one or more of the ingredients has been used, an ingredient foreign to the solution has been added, or not enough water was added to the solution. Measurements that fall below standard limits might indicate that something has been left out, that a foreign chemical has been substituted, or that more than the correct amount of water was added.

The silver content of a fixing bath increases as the bath becomes exhausted. This causes the specific gravity of the solution to rise. Hence, in addition to testing the consistency of chemical solutions, specific gravity tests may be used to check the amount of silver in the fixing bath. A hydrometer used for this purpose must be calibrated in grams of silver per liter of solution.

A hydrometer consists of a hollow tube with an enlarged lower section, or float, topped by a narrow stem. The lower section is weighted, so the hydrometer will float in liquids with its stem protruding from the surface. The stem is graduated with marks that are used to indicate the density of the liquid in which the hydrometer floats. When the density of the liquid is high, it supports the hydrometer more easily, so less of the stem is submerged. Less dense liquids allow the hydrometer to sink deeper.

Hydrometers are commonly graduated in terms of specific gravity. Specific gravity is the ratio of the density of a substance to the density of distilled water. However, hydrometers designed for special purposes have different types of graduated scales. An example is the hydrometer that is used to check the silver content of a fixing bath.

Because of the effects of surface tension and capillary action, a meniscus is formed at the interface between the solution and the hydrometer stem. The

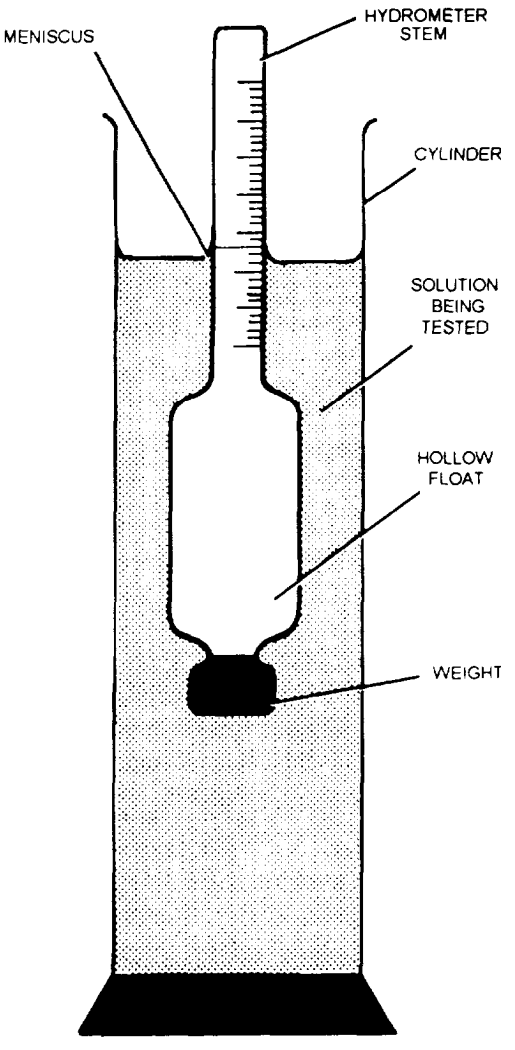


Figure 9-2.–Hydrometer.

reading is taken at the point where the top of the meniscus intersects the stem of the hydrometer (fig. 9-2).

pH METERS

The acid or alkali state of a solution is measured in pH values. The pH value of developers and fixers influences their activity and proper strength. pH is basically a measure of the degree of acidity or alkalinity of a solution. It provides an invaluable aid in determining the degree of accuracy with which the processing solutions have been prepared. Photographic developers usually have a pH of 8 to 12, while fixers range between pH 3.1 and 5.

The following scale indicates the location of acids and alkalis by their pH value (strength):

pH VALUES		
ACIDS	NEUTRAL	ALKALIS
1 2 3 4 5 6	7	8 9 10 11 12 13 14

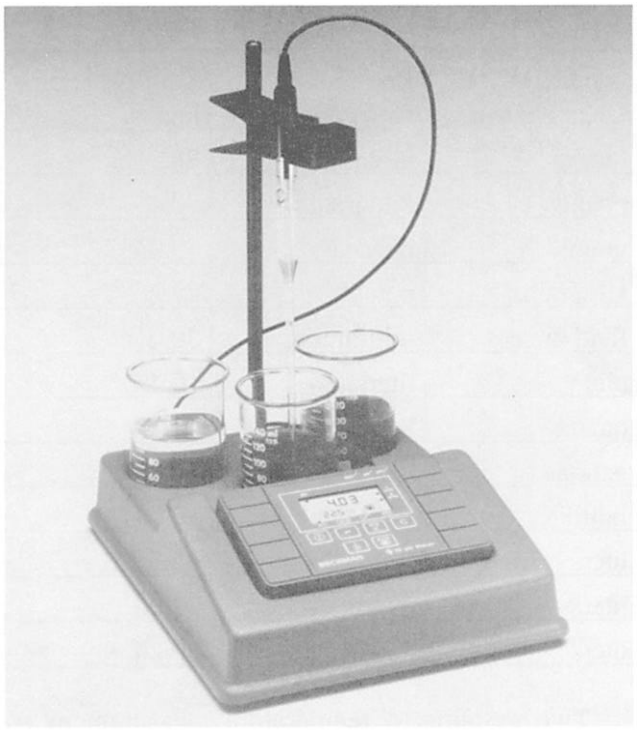
A pH of 7 is neutral. Working down from this point, the figures indicate weak acids with a pH of 6 on to strong acids with a pH of 1. Working up from a pH of 7, the figures indicate weak alkalis with a pH of 8 to strong alkalis with a pH of 14.

The pH values are numbered on a logarithmic scale. From 0 through 6, each number indicates a degree of acidity 1/10 as strong as the preceding number, but 10 times stronger than the next succeeding or higher number. A solution with a pH value of 4, for example, has a degree of acidity 10 times stronger than a solution with a pH value of 5, but only 1/100 the strength of a solution having a pH value of 2. When determining the degree of alkalinity of a solution, figure it in an opposite manner. From 8 through 14, each number represents a degree of alkalinity 10 times as strong as the last preceding number, but 1/10 the strength of the next higher number; for example, a solution having a pH value of 11 indicates that the solution has an alkalinity 1,000 times stronger than a solution having a pH value of 8, but it would be only 1/100 as alkaline as a solution having a pH value of 13.

Litmus paper is used to indicate whether a solution is acid, alkaline, or neutral, but it does not indicate the actual pH value. For this purpose a pH meter should be used.

A pH meter is an amplifier meter with a scale that reads from 0 to 14 and an electrode apparatus (Eg. 9-3). A pH meter has a reference electrode and a pH measuring electrode, or these two can be combined into one combination electrode. The pH electrode actually measures the pH, while the reference electrode that contains an electrolyte solution is used only to complete the electrical circuit. The first step in measuring pH is to establish a point of reference by a standardization procedure. To standardize the pH meter, you must place the electrodes in a calibrated buffer solution.

Buffer solutions are available at exact pH values for this precise standardization. Always select a buffer with a pH value as close as possible to the pH of the sample to be tested; for example, use a buffer at a pH of 4.00 to test a fixer solution or a pH of 10.00 to test a developer solution. The instrument should be standardized at regular intervals during a long series of measurements or before each use.



Courtesy of Beckman Instruments, Inc.
302.259X

Figure 9-3.–pH meter.



Courtesy of Kreonite, Inc.
302.20X

Figure 9-4.–Agitation mixers.

The ability of a pH meter to determine the pH value of a solution accurately may be used for the following purposes:

- To verify that chemicals have been properly mixed
- To test prepared chemicals
- To assure standardization of the processing solutions
- To determine the exact replenishment rates for photographic chemical solutions

Tolerances in pH values must be established for individual labs because of differences in procedures, types of equipment, impurities in water, and so forth. On the average, two readings from 10 different batches of each solution, mixed at different times, must be taken and recorded to establish these standards. These batches should be mixed as they would be for regular use but under very close control to ensure that the solutions are mixed at the correct temperature, in the proper sequence, and so forth. This operation helps in determining the tolerance. This tolerance is the amount of variation of the pH that still produces high-quality results.

The discussion of pH meters is intended as an introduction only. Detailed step-by-step operating instructions for pH meters are not included in this chapter. Operating instructions in the form of technical orders and manufacturer's manuals for specific pH meters will be available to you in your imaging facility.

MIXERS

In the Navy, we use two methods of mixing chemicals: hand mixing and machine mixing. Hand mixing is used when only small quantities of solutions are needed or when machines are not available. Machine mixing is necessary to handle the large production requirements of most Navy imaging facilities.

Agitation Mixers

Proper agitation of the solution during mixing increases the rate at which the chemicals are dissolved and prevents undesirable side effects. For proper agitation, an agitator type of mixer does not cause excessive amounts of air to enter into the solution (fig. 9-4). Developers are quickly ruined by oxidation; a few minutes of improper and violent agitation can

weaken a developer and cause it to underdevelop and sometimes stain film. Too little agitation during mixing may cause the powdered chemicals to settle to the bottom of the mixer and form hard lumps. When these lumps of chemicals are undissolved and undetected, they can clog pumps and plumbing during transfer from the mixer to the storage tank. These lumps can also cause the solution to be less active.

Agitation mixers circulate solutions through a pump that causes a stirring action. There are several types of agitation mixers available. These include large capacity models for preparing large volumes of solutions and small models for making small amounts of solution.

Impeller Mixers

Impeller mixers provide thorough, rapid mixing, but they must be used with care to prevent frothing or foaming and introducing air into the solution. The solution must be mixed so a minimum amount of air is drawn into it. When the shaft is placed in the center of the container, the impeller causes a whirlpool effect that introduces excessive amounts of air into the solution. Furthermore, when the shaft is in the center of a container, there is very little agitation in the bottom-center area of the container and undissolved chemicals pile up directly beneath the end of the shaft (fig. 9-5).

Avoid bumping the shaft or impeller on the sides or bottom of the mixing vessel. This procedure may bend the mixer shaft, and a bent shaft produces excessive vibrations that can ruin the motor bearings.

WEIGHTS AND MEASURES

The different systems of weights and measures used in chemical mixing and the relationship of the various units to one another are matters that every photographer who prepares photographic solutions should understand.

These days, photographic chemicals are prepackaged and are usually published in two systems of weights and measures: avoirdupois and metric. In the avoirdupois system, chemicals are weighed in ounces and pounds and are dissolved in pints, quarts, or gallons of water. In the metric system, they are weighed in fractions or multiples of grams and are dissolved in cubic centimeters or liters of water. With a conversion table, a formula given in one system can be easily converted to the other.

Weight and Volume Conversion

Number of Units Known	Resultant Units	Multiplication Factor
ounces	grams	28.3
pounds	kilograms	0.45
grams	ounces	0.0353
kilograms	pounds	2.2
fluid ounces	milliliters	30
pints	liters	0.47
quarts	liters	0.95
gallons	liters	3.8
milliliters	fluid ounces	0.034
liters	pints	2.1
liters	quarts	1.06
liters	gallons	0.26

Two systems of temperature measurement are used: Fahrenheit and Celsius. The Fahrenheit scale uses °F as a temperature symbol. The Celsius scale uses °C as its symbol. On the Fahrenheit scale 32 degrees is the freezing point of water, and the boiling point is 212 degrees. The difference is 180 degrees. The Celsius scale is 0 to 100 degrees from freezing to boiling. One degree Fahrenheit is smaller than one degree Celsius, one Fahrenheit degree being 5/9 of a Celsius degree. To convert Fahrenheit degrees into Celsius, subtract 32, multiply by 5 and divide by 9; that is, (°F – 32) x 5/9 = °C. To convert Celsius to Fahrenheit, multiply by 9, divide by 5, and add 32; that is, (°C x 9/5) + 32 = °F.

Some formulas use the word *parts* as a measure. They may call for two parts of one chemical, one part of another, and any number of parts of water. This is frequently done when two or more stock solutions must be combined to make the working solution. In such cases, the word *parts* means any convenient "volume" measurement may be used; however, the same measure should be used for everything required by the formula. A part may be a fluid ounce or a gallon, depending upon the total quantity of working solution needed Formulas use parts only when volume is to be measured.

The term *stock solution* identifies a concentrated chemical solution. A working solution is the solution used for processing. The working solution may be the same as the stock solution, but more than likely it is a diluted stock solution.

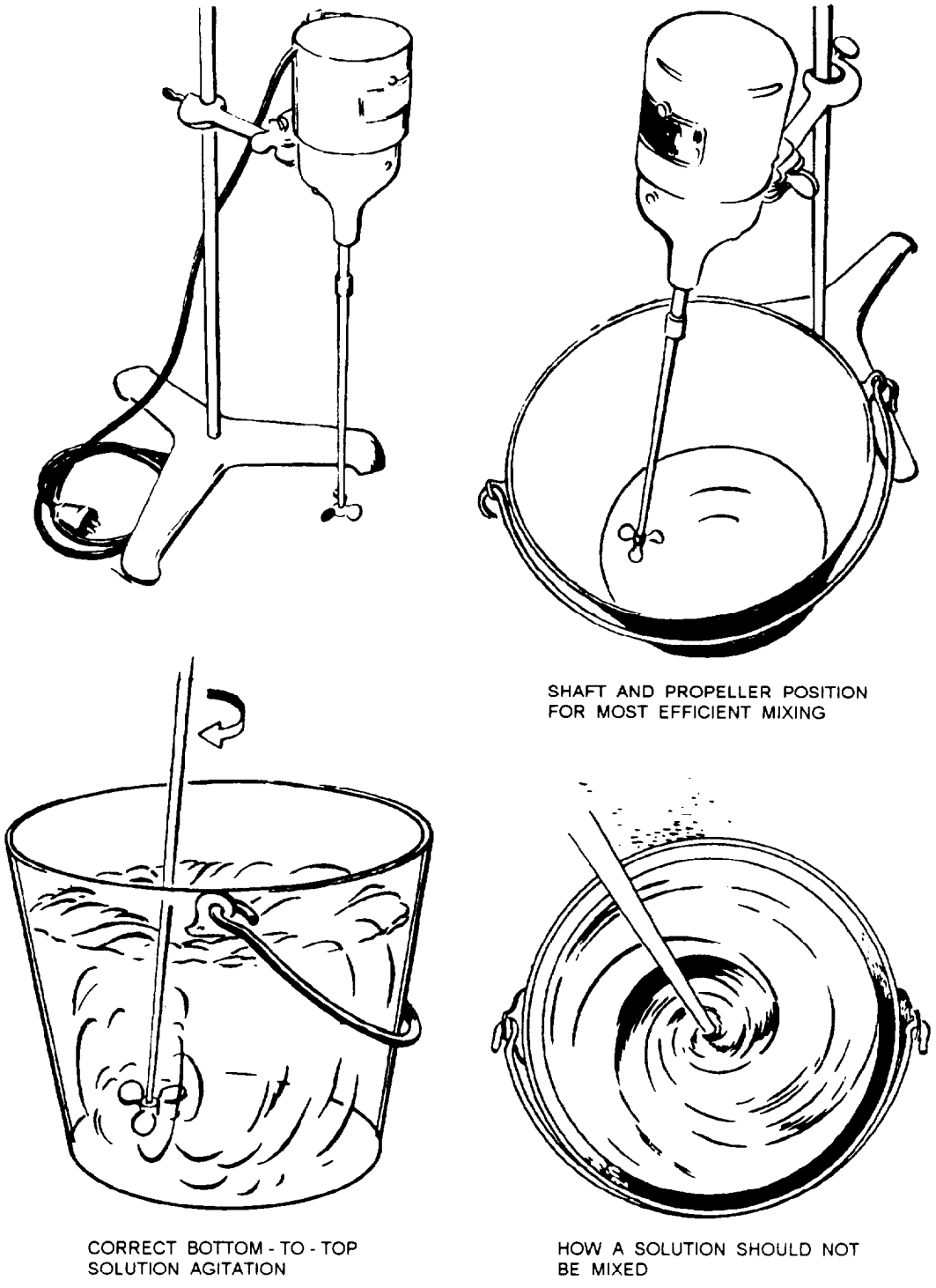


Figure 9-5.–Impeller mixers.

CHEMICAL MIXING RULES

For both personal safety and efficiency when mixing processing solutions, there are a few commonsense rules that you must follow. Mixing chemicals is simple enough, but even a slight error can change the working characteristics of some solutions. The principles of common cleanliness and precise measuring will prevent many chemical troubles. Without cleanliness and accuracy, many processes become guesswork.

Chemicals should not be mixed in areas where sensitized materials are handled or stored. Chemical

dust or fumes can ruin these materials. There should be adequate ventilation, a complete air change every 3 minutes, and an exhaust fan to the outside atmosphere in the area where chemicals are mixed.

CONTAINERS

Containers for photographic solutions should be made of a material that does not affect or is not affected by chemicals. Glass is the best material. Stainless steel is a highly suitable material, provided it is of the proper composition. Hard rubber and glazed earthenware may also be used satisfactorily. Acid and alkali-resistant plastic containers are acceptable.

Containers, graduates, sinks, and every utensil used in the photographic lab should always be clean. As soon as work is finished with an item of equipment, it should be cleaned and returned to its proper place. When chemicals are spilled, clean them up as soon as possible.

Chemical solutions and chemical dust corrode and cause pitting of most materials, including stainless steel, when allowed to remain for any length of time.

ACCURACY

Photographic quality suffers when the chemicals are improperly mixed. You must be certain that the amount of chemical you put into a solution is the amount specified.

The mixing of processing solutions has been greatly simplified over the years by the introduction of packaged photo-processing chemicals. Packaged chemicals come in convenient sizes for most needs. They offer standardized quality, economy, and convenience.

Packaged chemicals include film and paper developers and fixing solutions of various types that are manufactured under tightly controlled conditions. These packaged chemicals are available in either liquid or powder form. Processing solutions can be mixed easier, faster, and more accurately with packaged chemicals than with bulk chemicals.

When mixing packaged chemicals, you should always mix the entire package. Packaged chemicals usually contain more than one ingredient. During shipping and handling, these ingredients may separate with the heavier elements settling to the bottom of the package. When only part of the package is mixed, some of the ingredients that have separated or settled may not be put into the solution and the result of the process is not predictable.

MIXING

Always add chemicals to the water or solution Dry chemicals should be poured slowly into the water while it is being stirred. When preparing a developer, be careful while you are stirring so air is not beaten into the solution. When water is poured on dry chemicals, they will cake and form hard lumps that are difficult to dissolve.

Lumps or hard particles should be ground up, or crushed, with the stirring rod or with a pestle. Never add another chemical to a solution before the previous part has been completely dissolved Sometimes there is a residue that will not dissolve. The residue may be sand in the water supply, impurities in the chemicals, or other matter that found its way into the water; however, when the solution is allowed to stand for awhile, these particles usually settle and the clear liquid can be poured off. To remove sludge or dust particles that may not settle, pour the solution through a funnel containing three or four layers of cheesecloth or absorbent cotton.

Many chemicals are very sensitive to heat, and even moderate temperatures seriously affect their chemical properties. However, the rate of chemical reaction increases with an increase in temperature, and all chemicals dissolve more readily in warm water than in cool water; consequently, many formulas and instructions recommend that water as hot as 125°F be used to prepare the solution that must then be cooled to the correct processing temperature. You should always try to mix solutions at the minimum temperature recommended by the manufacturer. Solutions oxidize faster at higher temperatures because of increased chemical activity at these temperatures.

When all crystals are dissolved, the solution should be practically colorless. Sometimes a solution appears cloudy or milky for a short time after it is mixed. This appearance may be caused by air taken into the solution by the dry chemicals. Air taken into a solution is distributed through the solution as tiny bubbles that cannot escape while the solution is being stirred. When the presence of bubbles has caused the discoloration, the solution will clear up when it is allowed to stand for a while. The bubbles rise to the surface of the solution and escape into the air.

Always add acid to the water. This is as easy to remember as AAA (Always Add Acid). It is dangerous to pour water into an acid. Some acids generate heat

rapidly enough to cause boiling or a splashing explosion that may splash the solution on someone nearby. Acids should always be poured slowly into a solution (near the edge of the container) while rapidly but carefully stirring the liquid.

LABELS

Mixing tanks, storage tanks, and machine tanks for developer, stop bath, fixer, and other solutions must be labeled clearly with waterproof tape or nameplates to reduce the chance of putting a solution into the wrong tank. The label should contain the name of the solution, the date it was mixed, and the name of the person that mixed it. It is also mandatory that hazardous chemical labels be attached to all chemical containers.

CONTAMINATION

All of the mixing equipment and the mixing area must be cleaned immediately after use to prevent solution contamination. The mixing tools and tanks must be thoroughly cleaned right after use to prevent dried solutions from forming encrustations that could dissolve when a new solution is mixed. Mixing tools that have not been used in some time should be washed before use to remove any dust or dirt that may have accumulated.

PREPARATION OF PHOTOGRAPHIC SOLUTIONS

When mixing photo chemicals, you should always start with clean tools and a clean tank with the right amount of water-usually about one half to three fourths of the final volume. The temperature of the water must be as specified in the instructions. Developers are generally mixed at or about 90°F to 125°F, while fixers are mixed in water that should not be much above 80°F.

Always dissolve or dilute ingredients in the order called for by the instructions. Dry ingredients must be completely dissolved before the next ingredient is added. All liquids must be completely diluted, while stirring, before the next ingredient is added.

After a liquid is added to a solution, rinse the bottle and add the rinse water to the solution, so all the concentrated liquid is used.

After all ingredients have been combined and thoroughly dissolved, diluted, and mixed, water should be added to bring the solution up to the correct volume. Do not forget to mix this water thoroughly into the solution.

FOLLOW DIRECTIONS

Before mixing photographic chemicals, you should read the manufacturer's directions carefully. Much research goes into the production of chemical products; however, it is only effective when the chemical is mixed and used properly. The directions for even the most familiar product should be reviewed, because there are continual attempts to improve photographic materials; for example, new film or developer combinations may call for changes in dilution, processing time, or temperature to get the required results. Learn to follow directions. This is very important in the preparation of chemicals for both quality and safety reasons.

Remember to follow the proper procedures for chemical safety. You should prepare the chemicals in a well-lighted and well-ventilated room. Do not taste or inhale any chemical. You are required to wear rubber gloves, a rubber apron, eye protection, a long sleeve shirt, and a respirator for your personal protection. Remember, for safe mixing and quality results, FOLLOW DIRECTIONS.

CAUTION

In most imaging facilities, it is common practice to connect a hose to the water spigot to aid in filling a chemical mixing tank and to prevent splashing in the sink. Aboard ship, hoses attached to potable water spigots can back siphon chemicals from the tank or sink into the drinking water supply. Such hoses should either be removed after each use or have a backflow preventor installed in the plumbing system.

CHANGING PERCENTAGES

You must know how to prepare percentage solutions from liquid chemicals. When the chemical on hand is in liquid form and of known strength, a percentage solution can easily be prepared by the following method:

$$\frac{\text{Amount Wanted x Strength Desired}}{\text{Strength on Hand}}$$

Multiply the amount wanted by the strength desired and divide the product by the strength of the chemical on hand; for example, you need 11 ounces of 28 percent acetic acid. The chemical on hand is glacial acetic acid, 99.5 percent. Thus,

$$\frac{11 \times 28}{99.5} = \frac{308}{99.5} = 3.09 = 3 \textit{ ounces}$$

Add 3 ounces of 99.5 glacial acetic acid to 8 ounces of water to obtain 11 ounces of a 28 percent solution of acetic acid.

CHEMICAL SAFETY

Some of the chemicals used in photography are skin irritants, and others can cause serious injuries. Chemicals should be regarded as poisons and handled with caution. Before handling or working with photographic chemicals, you should become familiar with the safety precautions contained in Navy *Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat,* OPNAVINST 5100.19 series, volume I (chapters B3 and B12) and volume II (chapters C1, C9, and C23), *Navy Occupational Safety and Health (NAVOSH) Program Manual,* OPNAVINST 5100.23 series (chapters 15, 20, and app. 15), and *Safety Precautions for Photographic Personnel,* NAVAIR 10-1-764.

Because of the danger of contaminating your fingers, all precautions concerning poisons should be observed when you are mixing photographic solutions.

Ingestion of a poisonous chemical is commonly induced by hands that are contaminated with a toxic chemical. You should adhere to the precautions published for photographic chemicals to avoid contact or ingestion of poisonous or corrosive chemicals. Regardless of the antidote given to anyone that has been accidentally exposed to or has swallowed a poisonous or corrosive chemical, the antidote is for EMERGENCY USE ONLY. The affected person should report to the MEDICAL DEPARTMENT IMMEDIATELY.

ACIDS AND ALKALIES

There are many types of acids and alkalies used in photography. In general, acids and alkalies are similar in their injurious properties in that either may cause the following:

- Corrosion (chemical burn) by direct contact with the skin or eyes or indirectly through the clothing.

- Intoxication or suffocation by inhalation of their fumes. The fumes of some compounds are toxic or poisonous, while others displace air, thereby producing a suffocating atmosphere.

- Poisoning when taken internally.

- Fire and explosion because of their instability under adverse storage conditions. Also, some acids are strong oxidizing agents that can generate ignition temperatures upon contact with organic materials and other chemicals.

PRECAUTIONS

There are several safety items that must be worn when mixing chemicals. They are as follows:

1. Face shield or goggles-Protects the eyes from caustic chemicals.
2. Plastic or rubber apron-Reduces the chance of chemical contamination of clothing.
3. Rubber gloves-Protects the hands and lower arms. Gloves should extend up to the elbows.
4. Respirators-Used to prevent the inhalation of fumes or chemical dust. The correct cartridge must be used for the type of chemical being mixed as described in *Navy Occupational Safety and Health (NAVOSH) Program Manual,* OPNAVINST 5100.23 series (app. 15). Respirators must be cleaned and sanitized with alcohol and placed in an airtight bag after each use.
5. Long sleeve shirt-Used to protect the arms.

The majority of photographic chemicals cause the skin to dry out due to the removal of natural skin oils. Some types of chemistry have an accumulative nature. This is when some of the chemicals are being absorbed into the skin layers during each exposure to the chemistry. The chemistry then replaces some of the natural oils that lubricate the skin. Over an extended period of time, which varies for different people, accumulation could result in a total breakdown of the ability of the skin to produce natural fats and lubricating oils. Extreme conditions can result in contact dermatitis. Metol (developing agent) poisoning can be a result of accumulation poisoning.

Certain precautions must be observed in areas where acids and strong alkalies are handled. These precautions are as follows:

- Warning signs and labels-Signs should be posted in the chemical mixing area, warning personnel of the principal hazards of the chemical being used. All containers must be properly identified with hazardous material labels.

- Showers and eyewash stations-Showers and eyewash stations must be provided near all chemical mixing areas.

- Ventilation-In a chemical mixing area, exhaust ventilation must be provided The exhaust vent must draw vapors away from the person mixing the chemicals and provide a complete air change once every 3 minutes (20 changes per hour).

- Mixing and diluting-Strong acids and strong oxidizing agents may react violently or produce explosive products. Toxic gases may be created when acid is mixed with such chemicals as sulfides, cyanides, nitrates, and nitrites. Diluting acids with water can generate considerable heat; acid should always be added to water, not water to acid. The addition should be done slowly with constant stirring.

- Never smell a chemical directly from the bottle; instead, hold the bottle at a distance from your nose and sniff its contents cautiously rather than inhale directly.

- Never taste a chemical.

- Handle all chemicals cautiously; many can produce burns or skin irritation.

MATERIAL SAFETY DATA SHEETS (MSDS)

In addition to the precautions listed previously, every person in your imaging facility must be completely familiar with the Material Safety Data Sheets (MSDS) for each chemical solution used in your photographic production. The MSDS are provided by all the manufacturers of hazardous materials. You are required to have the MSDS for each solution. The Occupational Safety and Health Administration (OSHA), as well as your safety officer, performs periodic safety inspections of your imaging facility. Every person is responsible for the location and information contained in the MSDS. MSDS are generally broken down into 12 sections as follows:

1. Product Information
2. Component Information
3. Precautionary Label Statements
4. Physical Data
5. Fire and Explosion Hazard
6. Reactivity Data
7. Toxicological Properties
8. Protection and Preventive Measures
9. Storage and Disposal
10. First Aid
11. Transportation
12. Preparation Information

It should be noted that separate MSDS may apply to working solutions and stock solutions or concentrates. Be certain that the MSDS apply to the chemical you are in contact with.

ENVIRONMENTAL ISSUES

The Environmental Protection Agency (EPA) has tightened regulations drastically and they have a substantial impact on the way imaging facilities conduct business. All Hazardous Materials (HAZMAT) must be handled in complete compliance with EPA regulations. The regulations and tolerances differ from state to state and base to base. It is important that you comply with the regulations in your local area

DISPOSING OF HAZARDOUS MATERIALS

Before you pour photographic chemicals down the drain or throw material in the dumpster or over the side, you must be certain that you are not violating any hazardous material handling or disposal procedures. You should be completely familiar with the environmental protection standards and the Ship's Hazardous Material List for all items that apply to your command. EPA regulations state that anyone violating environmental protection regulations can be personally accountable and fined. When you have ANY doubt, ask your supervisor before disposing of the material(s).

The MSDS provide information on how to neutralize and clean up spill containment of photographic chemicals. When handling and cleaning up chemical spills, be sure you follow all safety precautions mentioned previously. It is important that any chemical spill be cleaned up immediately because many chemicals are extremely corrosive. These chemicals may damage or stain the surfaces with which they come into contact. Consult your local directives on disposing of materials used to clean up chemical spills as well as the chemicals themselves.

SILVER RECOVERY

Silver contained in photographic emulsions and used fixers and bleaches are considered hazardous

material. Silver recovery was established originally to reclaim the silver from these materials and reclaim for money that was returned to the Department of Defense. Today, however, when not performed, silver recovery could be very costly in the fines that may occur when photographic materials are not disposed of properly. Be certain that you know the proper handling procedures for photographic materials that contain silver.

CHAPTER 10

IMAGE PROCESSING AND CONTROL

As a Navy photographer, you must realize that composing and exposing a scene on film does not guarantee top-quality photography. The quality of the finished print depends on the quality of your darkroom work. A perfectly exposed film is useless if it is fogged, scratched, or under- or overdeveloped. Therefore, each step of film processing is important and you must master each step.

During the discussion of *basic* film processing concepts, both black-and-white and color film processing are covered. The mechanics of black and white and color processing are very similar. The primary differences between processing color film and processing black-and-white film are there are more steps in a color film process, and the time and temperature requirements are more critical.

DEVELOPERS AND DEVELOPMENT

The purpose of development is to convert those parts of the light-sensitive material (film or paper) that has been affected by light to black metallic silver. This produces a visible image from the invisible latent image. Development is usually carried out by bringing the exposed film into contact with a solution that contains a developing agent, but no silver salt. The silver that forms the developed image comes from a reduction of the individual silver halide grains in the film emulsion. This process is called *chemical or direct development.*

In another process that is seldom used, the developed image is derived from a soluble silver salt contained in the developing solution itself. This process is called *physical development.* The physical development process can be difficult to use because there is a tendency for silver to be deposited where it is not wanted.

The process of *chemical development* is most commonly used for film development. Chemical development is the process with which you should be concerned. In chemical development, the individual silver halide grains in the film emulsion are reduced to a black metallic silver. Each grain in the emulsion acts as a unit, in the sense that a grain is either developable as a whole or is not developable. When film development is performed properly, only exposed grains containing a latent image are reduced to black metallic silver. You may ask, "Why doesn't the developer develop the unexposed grains as well as the exposed grains?" Actually, the unexposed grains are develop able. When development is carried out over a long enough period of time, all grains are developed or reduced to black metallic silver. The density that results from the development of unexposed silver halides is called *fog.* Thus development is a rate phenomenon and the development of the exposed grains takes place at a faster rate than the unexposed grains.

The individual grains of silver halide in an emulsion are protected against the action of the developer by a chemical layer. When light strikes the emulsion, it breaks down the protective layer at one or more points on each individual *light-struck* grain. When the exposed film is placed into the developer, the grains are acted upon at these points by the developing agent, and each grain that received more than minimum exposure is quickly reduced to black metallic silver. The amount of blackening (density) over the film surface depends primarily upon the number of grains that have been affected by the developer. Density is also influenced because some grains may not develop to completion in the time the developer is allowed to act on the film.

COMPOSITION OF A DEVELOPER

There are many different formulas used as developing solutions, but most developers contain the following four essential ingredients: developing agent, preservative, accelerator or activator, and restrainer.

DEVELOPING AGENT

The developing agent, commonly referred to as the *reducing agent*, is the most important chemical in a developing solution. It is the developing agent that actually converts the silver halide grains in the emulsion to metallic silver. Nevertheless, the other ingredients are necessary to make the solution function properly.

One of the properties of a developing agent is its reducing potential. This refers to its relative ability to develop or reduce the silver halides. An active developing agent attacks silver halides vigorously, whereas one of low potential is slower in its action. For

certain purposes, one agent may be preferred over another. The temperature of the solution affects the activity of some agents much more than others. Hydroquinone, Metol, paraphenylenediamine, and phenidone are some of the more commonly used developing agents.

PRESERVATIVE

All developing agents in an alkaline state are affected by oxygen. When the developing agent combines with the oxygen in the air, the efficiency of the developing agent is reduced. When elements combine with free oxygen from the air or water, *oxidation* occurs. Therefore, a preservative is added to developing solutions to prevent excessive oxidation. The preservative prolongs the useful life of the developing solution and prevents stains caused by the formation of colored oxidation products.

The preservative is a chemical with a great attraction for free oxygen and combines with it when mixed into a solution. A large amount of free oxygen is in the water used for solutions. When the free oxygen is left in the water, it oxidizes most of the developing agent and produces stains before the metallic silver image is developed completely. By adding enough preservative, you may remove practically all of the free oxygen from the solution, the developing agent works as intended, and no stains are produced. Sodium sulfite is the preservative most commonly used in developing solutions.

ACCELERATOR

All developing *agents* (not developing *solutions)* are either neutral or slightly acid. Most developing agents must be in an alkaline state to be effective reducing agents, thus solutions require an alkali to activate the developing agent. A developing *solution* contains an accelerator so the solution becomes alkaline.

The accelerator serves two functions. First, it speeds up the swelling of the gelatin in the emulsion. This swelling permits the solution to penetrate the entire emulsion more quickly. The effect of this action is physical. The second action is completely chemical. As the silver halide salts in the latent image are reduced by the developing agent, the halide elements freed from the silver are absorbed by the accelerator and combined into neutral salts. This prevents harmful effects in the solution.

Because the accelerator is a determining factor in the activity of a developing solution, it affects the degree of graininess produced in the negative. This graininess is dependent upon the clumping action of the silver grains during the development process. The more active the developer, the higher the pH, and the greater the clumping action. Therefore, the milder or less alkaline developers yield finer grain. Common accelerators used in developing solutions are sodium carbonate and potassium carbonate.

Without an accelerator, there is little or no action. With some accelerators there is too much action. By the addition of a bromide restrainer, you may slow down the action of the developing solution to a controllable degree.

RESTRAINER

Without a restrainer most developing solutions act too rapidly and develop unexposed silver halides near the surface of the emulsion. This causes chemical fog, developing streaks, and an image with low contrast. During development, some restrainer is released from the silver and has a restraining action on the reducing agent during development. However, its action is not enough to prevent fog. When a restrainer is added, development time is prolonged and fog is minimized. Contrast is increased because the activity of the developing agent is cut down in unexposed areas. However, too much restrainer greatly retards the amount of development. The chemical most commonly used as a restrainer is potassium bromide.

TYPES OF BLACK-AND-WHITE DEVELOPERS

As stated previously, when a photographic emulsion is exposed to light, there is an invisible change produced in the minute crystals of silver halides that results in a latent image. To make the image visible, you must treat the exposed emulsion in a solution known as a developer. This solution converts the halides affected by light to black metallic silver. These black metallic silver particles form the visible image on the negative.

At the beginning of development, there is little difference in density between the highlight and shadow areas of the film. However, during normal development, this difference increases because the highlight densities continue to increase after the shadow areas are completely developed. Development should stop when the contrast between the shadows and highlights reaches a desired difference. The activity of the developer, and to some extent the type of film, primarily determines this developing action.

One type of developer cannot cover all situations; for example, film exposed by poor lighting conditions may require an active developer to bring out as much of the image as possible, while a film exposed under normal conditions requires a normal working developer. There are many different developers, each provides different activity and quality of development. The actual choice of the developer to use depends on the type of film, conditions under which it was exposed, type of negative required, and the developing time that is best for your development method.

GENERAL-PURPOSE DEVELOPERS

A developer for general-purpose work should produce moderate grain, normal contrast images. Clear areas of the negative, as well as the image areas, should be basically fog free.

Some general-purpose developers are as follows:

- HC-110
- DK-50
- Microdol

FINE-GRAIN DEVELOPERS

All photographic emulsions have a grainy structure. Although this grainy structure is not normally visible to the naked eye, it becomes visible whenever high magnifications are used to make prints. The tendency to use small-format film and make large enlargements has resulted in the need for fine-grain developers.

When enlargements are made from small negatives developed in other than fine-grain developer, the grain of the film may be objectionable. Graininess in the film should be *controlled* in the development of the film. Keep in mind, however, that every film has its own grain structure or characteristics. For 35mm-roll film, it is normally best to use a fine-grain developer.

Fine-grain developers achieve the desired result in several ways:

- They are usually soft working and this tends to reduce clumping of the silver grains.
- Some fine-grain developers actually produce smaller individual grains of black metallic silver. This, however, tends to reduce the film speed.
- The grayish white images produced by some fine-grain developers help by providing for increased passage of light between individual grains. This results in less local variation in density.
- Most fine-grain developers produce relatively low-contrast negatives. A reduction in contrast in the negative tends to reduce the graininess of the negative. However, this may not contribute significantly to a reduction in the graininess of the final print. Any advantage achieved by lowering negative contrast may be offset by the need to use a higher contrast printing filter to print the negative.

Some fine-grain developers are as follows:

- ID-l1 (Ilford)
- D-76 (Kodak)
- Atomal (Agfa)

HIGH-CONTRAST DEVELOPERS

To produce maximum contrast on process and line copy type of films, you must have a developer that produces density readily and is free from any tendency to produce fog within the time of development.

Some of the most popular high-contrast developers are as follows:

- Kodalith (Kodak)
- D-11 (Kodak)
- D-19 (Kodak)

To prevent staining when using a high-contrast developer, you should rinse the negative well between developing and fixing.

HIGH-DEFINITION DEVELOPERS

A high-definition, or compensating, developer adds increased sharpness to the image by enhancing contrast of image edges and fine detail in the negative. High-definition developers may increase film speed by one or two f/stops, but they also increase graininess. High-definition developers are recommended for use only with fine-grain (slow or medium speed) films.

Some of the high-definition developers are as follows:

- Acufine
- Ethol TEC

You should consult the film data sheets or the *Photo-Lab-Index* for the recommended developers for each particular type of film to be processed.

CHANGES IN DEVELOPER WITH USE

The function of a developer is to change chemically the sensitized material treated in it. It stands to reason then that a chemical change also takes place to the developer itself. Most developers are used more than once. Therefore, you must know what changes to the developer can be expected and what can be done to prevent them or at least compensate for them. The primary changes that occur to a developer as it is used are as follows:

- Some developer is removed or carried out with the film and on the film hangers or reels.

- The developing agents are used up by reduction of silver halides to black metallic silver and by aerial oxidation. When the developing agents are used up by the reduction of silver halides, the by-products of the reaction cause the pH of the solution to drop, thus becoming more acid. When the developer agents are used up by oxidation, the pH tends to rise.

- The preservative is used up, thus the developing agents oxidize faster.

- The bromide within the solution is increased because the bromide is released from the film emulsion itself.

The effects of these changes to a developer are as follows:

- The development time required to reach a given contrast index or gamma is increased. Therefore, when a developer is used over and over, development time must be increased as more film is developed.

- The effective film speed produced by the developer decreases because of the increased bromide (a restrainer) in solution. However, this speed loss may be partially offset by increasing development time to maintain image contrast.

Complete exhaustion of a developer occurs when the developing agents are all used up. The approach of exhaustion is characterized by a brown color of the solution. Since a developer in this state can stain sensitized materials, it should not be used.

In most Navy imaging facilities, it is not economical to use a developer to the practical exhaustion point and then discard it. The quality of the image usually suffers long before the exhaustion point of the developer is reached. Replenishers are usually used to prevent this from happening.

Replenishment of a developer involves replacing those chemicals in the used developer that are exhausted by a replenisher so that the developer remains consistent. The aim of replenishment is not to keep the composition of the developer constant but to keep its activity constant.

There are two commonly used methods of replenishment. The first or “topping off” method is used extensively in tank processing. When topping off is used, the developer solution is maintained at a constant level in the tank by adding replenisher, so the volume added is equal to the amount of developer carried out. When you are replenishing by this method, it is possible to maintain consistency in development for only a certain period of time. After a given volume of replenisher has been added to the developer, the developer must be discarded. This procedure is then repeated with new developer.

The second replenishment method is called the "bleed" method. The bleed method is used primarily with machine processing where a circulating developer system is used. In the bleed method, used developer is drained off and replenisher (in proportion to the amount of film processed) is fed in, so the characteristics and the level of the developer in the machine remain constant.

FIXING, WASHING, AND DRYING

As soon as a light-sensitive material is developed, it contains a visible silver image, but the image is not ready to be exposed to light. Only a portion of the silver halides in the emulsion were reduced to black metallic silver by the developer. The silver halides that were not reduced restrict both the immediate usefulness and the permanence of the image. These undeveloped silver halides must be removed. This is the purpose of the fixing bath. Before treating the sensitized material in the fixer (as it is called), you must stop or at least slow down the action of the developer. When the light-sensitive material is removed from the developer solution, there is a small amount of developer both in the emulsion and on the surface that must be removed or neutralized. For this, you use either a water rinse bath or an acid stop bath.

WATER RINSE BATH

To *slow* down the action of development, you must immerse the film in a water rinse bath. A plain water rinse bath is commonly used between development and fixation to *slow down* the development by removing all the developer that is clinging to the film (or paper) surface. A rinse bath does not completely stop development but retards it. A rinse bath has little affect on the developer that is actually in the swollen emulsion.

Rinsing is accomplished by quickly immersing the film in plain, clean water. A water rinse bath should be changed often to ensure it does not become loaded with developer. It is better to use running water.

The rinse bath, then, serves two purposes: first, it slows down development and second, it reduces the work that has to be done by the acid in the fixer. Rinsing, therefore, protects or prolongs the useful life of the fixer.

Following rinsing in plain water, the material (that is still light sensitive) must be treated in an acid fixing bath to *stop* the development.

ACID STOP BATH

Although a plain water rinse bath is commonly used between development and fixation, a better procedure is to use an *acid* stop bath. The function of a stop bath is not only to remove the developer that is clinging to the surface of the material but to also neutralize the developer in the swollen emulsion to *stop* development completely.

The acid stop bath stops the action of the developer because developing agents cannot work in an acid solution. An acid stop bath also helps protect or prolong the life of the fixer by neutralizing developer carry-over.

An acid stop bath should meet the following requirements:

- lThe pH must be low enough to neutralize the action of the developer carried over.

- The acidity should be limited so the small amount carried over into the fixing bath does not increase the free-acid content of the fixing bath and cause sulfurization.

- It must not contain enough acid to produce blister formations in an emulsion.

You should use only a weak acid stop bath between development and fixation. Strong acid and the acid in the fixing bath have a tendency to form carbon dioxide gas bubbles in the emulsion. When the film is taken from the developer and placed directly into a strong acid or fixing bath, these bubbles may break and cause small, round holes in the emulsion. These bubbles are sometimes mistaken for pinholes like those caused by dust particles settling on the emulsion before camera exposure.

When you are using an acid stop bath, remember that some of the stop bath is carried into the fixer when materials pass through it. Therefore, you cannot use a strong acid (such as sulfuric acid) because it can cause precipitation of sulphur in the fixer. Acetic acid is the type of acid used for stop baths. In its pure form as *glacial acetic acid* (99.5 percent), it freezes at a temperature of about 61°F. Its freezing tendency gives it the name "glacial." For use as a stop bath, 99.5 percent glacial acetic acid is diluted with water to make a 28 percent working solution. Approximately 1/2 ounce of 28 percent acetic (not glacial) acid is added to 32 ounces of water. The process of determining the concentration of a liquid is discussed in chapter 8.

FIXING

When a light-sensitive material is removed from the developing solution, the emulsion contains a large amount of silver salts (halides) that has not been affected (developed) by the developing agents. This silver salt is still sensitive to light, and if it remains in the emulsion, light ultimately darkens and discolors the salt which obscures the image. Obviously, when this action occurs, the negative (or print) is useless.

The fixing bath is used to prevent this discoloration and to make the developed image permanent. It accomplishes this by removing the undeveloped silver halides by making them water soluble. Therefore, to make an image permanent, you must "fix" the light-sensitive material by removing all of the unaffected silver salt from the emulsion.

The fixing bath contains five basic ingredients: the fixing agent, preservative, neutralizer or acidifier, hardening agent, and an antisludge agent.

Fixing Agent

All fixing baths must contain a silver halide (salt) solvent. This solvent is known as a fixer or fixing agent. The two most commonly used in photography are sodium and ammonium thiosulfate, commonly termed *hypo* (taken from their other chemical name hyposulfite). Ammonium thiosulfate is used in rapid fixers that are stronger and require less fixing time.

Sodium and ammonium thiosulfate changes undeveloped silver halide to soluble silver sodium thiosulfate. It removes this compound from the emulsion and refills the space it occupied with nonexhausted fixing solution. Therefore, the function of the fixing agent is to convert the silver salts remaining in the emulsion after development to soluble compounds and to remove these soluble compounds by constantly diluting and replacing them in the emulsion. The number of substances capable of functioning as fixing agents is small because a good fixer must meet the following requirements:

- It must dissolve silver salts without affecting the metallic silver image.
- The compounds it forms must be soluble so they can be removed from the emulsion.
- The fixer should neither swell excessively nor soften the gelatin.

Preservative

A preservative prevents oxidation of the developing agents that are carried over into the fixing bath by the film. It also prevents decomposition of the fixer. Oxidized developer in a fixing bath produces stains.

Strong acids may cause a fixing agent to decompose (sulfurize). You must add preservative (sodium sulfite) in the fixer to prevent sulfurization. The preservative prevents the acid from decomposing hypo into free sulfur, prevents discoloration of the solution because of oxidation, and aids in preventing stains.

Neutralizer

After development, the pores of the swollen emulsion retain a portion of the developer. If allowed to remain, the developer continues its activity. Even when the emulsion is thoroughly rinsed in a water bath before being placed in the fixer, some developer activity remains. This causes uneven stains in the gelatin of the emulsion and makes the negative unusable. To stop development and prevent stains, you must add an acid neutralizer to the fixer. The most frequently used neutralizer is acetic acid.

Hardening Agent

During development, the gelatin becomes softened and swells. Frilling, reticulation, scratches, and other undesirable effects may result when processing is continued without hardening the emulsion. A hardening agent is included in the fixer to harden the emulsion in the fixing bath. The most common hardening agent is potassium alum. The hardening and toughening of the gelatin by the alum stops the tendency of the emulsion to swell but leaves it expanded and rigid enough for the washing process.

Antisludge Agent

The pH range of the fixer is limited. It must be low enough to neutralize the activity of the developer and also be high enough to prevent sulfurization. The reduced acidity of the bath is gradually neutralized by the alkali of the developer carried into the fixer by the film. When the active acidity is neutralized too far, a sludge of aluminum sulfite forms that can make the fixer useless. An antisludge agent, such as boric acid, is added to the fixer. This agent is capable of absorbing a large quantity of the developer before sludge occurs, thus lengthening the useful life of the fixer.

Time Required for Fixing

The time required for film to fix depends on several factors:

- The type of emulsion and its thickness. All else being equal. fine-grain emulsions fix faster than coarse-grained ones. Thin emulsions require less time to fix than thick emulsions.
- The type of fixing bath and degree of exhaustion. When sodium thiosulfate is the fixing agent, a concentration of about 75 percent gives the fastest rate of fixation. However, because of the tendency of hypo to bleach out the image, most fixers for negatives have a concentration between 20 and 40 percent.
- The fixing bath temperature. An increase in the temperature increases the rate of fixation. (Do not interpret this to mean that you can raise the temperature of the fixer above the temperature called for by the particular process being used.) The temperature of the fixer is not as critical as the temperature of the developer. However, you should keep all processing solution temperatures constant to avoid an increase of graininess.
- The amount of agitation. The rate of fixation is affected by diffusion of the chemicals, so agitation reduces fixation time.
- The amount of exposure. The more exposure the film has to light, the less unused silver halide to be removed by the fixer, and hence the faster the rate of fixation.

As a general rule, a film is considered completely fixed after twice the time it takes to *clear* it. Clearing or fixation occurs when all visible traces of the silver halides (a milky appearance) have disappeared. The clearing time can be determined by taking an undeveloped piece of the same type of film and agitating the film in the fixer until it clears. This procedure can be performed under normal room lights. The tongue cut from the beginning of the 35mm film may be used for this purpose.

Life of a Fixing Bath

The useful life of a fixing bath depends on several factors. One of which is the amount of material treated in the fixing bath. You cannot state accurately the exact amount of film or paper that can be safely fixed in a given amount of fixer. It is common practice to consider the fixer exhausted when the clearing time for the film is double the time it was originally. For a fixer used solely for prints, this is not easy to determine; therefore, the life of the fixer is considered ended after a given amount of paper has passed through it. This is usually about 200 8x10 prints (or equivalent) per gallon of fixer.

Using an exhausted or near exhausted fixing bath may cause the staining of films and paper. To avoid such staining, use two fixing baths in succession is the best practice. Initially, two fresh fixing baths are used. The materials are treated in the first bath until they are just cleared; then they are transferred to the second fixing bath for an equal period of time. In time, clearing time in the first bath (which is doing most of the fixation) is doubled from the original time required when the bath was fresh. When this occurs, the first bath is removed from use and replaced by the second bath. The second fixing bath is replaced by a completely fresh solution. This process is repeated as required, so the second bath is always relatively fresh. Using this procedure ensures that all film (and photographic paper) leaves the second fixer in stable condition and does not fade with time. This method is also economical, because all fixer is used to a point beyond that at which a single bath could be used.

WASHING

An unwashed or improperly washed emulsion will stain, crystallize, and fade. Therefore, the washing of the photographic emulsion is as important as any other part of processing. Removing as much of the salt and fixer from the emulsion is essential. Only by good washing techniques can image permanence be assured.

The purpose of washing is to remove the soluble salts from the emulsion. Fixing converts silver salts into soluble salts that must be removed. If the fixing process is incomplete, even prolonged washing cannot make the image permanent. This is because the compounds of silver sodium thiosulfate remaining in the emulsion discolor in time and produce stains. Thorough washing is necessary to remove the fixing agent that, if allowed to remain, slowly combines with the silver image to produce brownish yellow stains of silver sulfide and causes the image to fade.

Water containing iron should not be used for washing. However, impurities, such as rust, dirt, or silt, can be removed by installing a 5 micron water filter in the supply line.

Seawater may be used to wash negatives if it is followed with a freshwater rinse. Salt water removes the hypo from film in about two thirds of the time required for a freshwater wash. However, a short rinse with fresh water is required to remove the salt from the film.

Temperature, chemical contamination, and rate of water change all affect the time required to wash film correctly.

Temperature

The wash should be kept within a range of 60°F to 75°F (15.6°C to 23.9°C). Within this range of wash temperatures, the warmer the water, the shorter the washing time required. However, for black-and-white film, a wash temperature of 75°F should not be exceeded. Water at temperatures above 75°F swells the gelatin and tends to inhibit diffusion. It also can damage the emulsion. Therefore, you should keep the temperature of the wash water constant with the processing solutions.

Chemical Contamination

Adding negatives fresh from the fixer into a tank of partially washed negatives nullifies the effects of previous washing, and you must start the washing procedure again. The reason for this is that the negatives with the higher concentration of fixer add enough chemicals to the washed negatives to contaminate the partially washed film. This situation can also occur if

your hands are contaminated by chemicals when you place them in the wash tank.

Rate of Water Change

The length of washing time also depends on the diffusion of the hypo from the emulsion of the material. The rate of diffusion depends on the amount of fresh water coming into contact with the emulsion. Hypo remaining in the emulsion is continually halved in equal periods of time as the washing proceeds; for example, the average negative gives up about one half of the hypo it contains in 1 minute when in direct contact with running water. After 2 minutes, one fourth of the hypo remains, and so on, until the amount of hypo remaining eventually becomes negligible. Thus the rate of washing depends upon the degree of agitation and the amount of fresh water that comes in contact with the emulsion. The minimum washing time for negatives in running water is 20 minutes when a complete change of water occurs every 3 minutes.

Rapid film washers are designed to provide a constant freshwater exchange across the film emulsion. When rapid film washers are used, such as a Hurricane type of film washer, the film can be washed satisfactorily in 5 minutes.

WETTING AGENT

After washing, water often drains from film in an irregular manner, clinging to both emulsion and base sides in drops, streaks, and uneven patterns. When such partially drained or incompletely wiped films are subjected to hot air or radiant heat, the areas under these streaks and drops of water dry much more slowly than the surrounding film. The swollen gelatin at these points is subjected to stresses and shrinks unevenly, changing the density of the silver image. When surplus water is removed from the emulsion side and drops of water remain on the base side, drying of the emulsion immediately opposite the water spots is retarded and drying marks usually result. The use of a wetting agent helps to prevent the formation of these water spots.

Wetting agents are chemicals that “superwet” the film to promote faster and more even drying. Wetting agents are chemically different from soaps, but they perform a related function. They all lower surface tension of liquids so the film surfaces are wetted quickly and evenly. Kodak Photo-Flo is a wetting agent used in imaging facilities.

After washing, bathe the film in a 1- or 2percent solution of wetting agent (prepared according to instructions provided by the manufacturer) for about 2 minutes. Then drain the film briefly for about 30 seconds. Squeegee the film between your index and middle finger to remove surface foam and excess wetting agent. Be sure your hands are clean and dampened with the wetting solution before squeegeeing the film.

DRYING

The final step in processing is to dry the wet film. This step should be given special attention. Film drying has two distinct phases. The first is the removal of excess water from the film surfaces. The second is the drying of the film by evaporation.

When you are drying the film, the primary problems you must guard against are uneven drying, dust, scratches, and damage to the emulsion caused by overheating. Dry the film in a vertical position, hanging it from a line or beam by film clips. When you are drying roll film, curling can be avoided by hanging another film clip at the bottom of a strip of film. Sheet film should be hung from one corner of the film to prevent drying streaks. Film should not normally be dried in the hanger or reel in which it was processed, since *uneven drying results.*

Dust and water spots are the problems you encounter most frequently when drying films. When the dust is not embedded in the emulsion, you can remove it with a camel-hair brush. Embedded dust in the film requires the film to be rewashed and dried properly. Water spots are more serious, since uneven drying can cause not only white stains but also small craterlike formations in the film under each spot. The white stains can be removed with alcohol, but the craterlike spots become a permanent defect. The best cure is prevention. You can avoid these problems by keeping the film surface clean and by using a wetting agent before drying.

The photographic emulsion consists of one or more layers of gelatin with silver halides of varying sizes distributed through the layers. After exposure and development, the halides are changed to metallic silver that occupies space and does not absorb water. In an emulsion that is unexposed, the undeveloped silver salts are made soluble and are removed from the emulsion during the fixing and washing stages. Only the gelatin and the space occupied by the halides remain, and these do absorb water. Because of these conditions, dense

negatives, or negatives containing many heavily exposed areas, contain less water and dry faster than thin negatives. When you think about this for a moment, you can see that since the heavily exposed and lightly exposed areas are distributed randomly throughout the average negative, drying occurs rapidly in the dense areas, more slowly in the intermediate areas, and most slowly in the thin or unexposed areas. Obviously, then, film does not dry uniformly.

When gelatin dries, the water it contains must first migrate to the surface and then evaporate into the air. Ideally, these processes should take place simultaneously and at the same rate. However, when the surface moisture evaporates too rapidly, the surface becomes hard, and the internal moisture is unable to escape it. In addition, when drying is too rapid, the outer surface shrinks while the rest of the gelatin layer is in an expanded state. This causes strains that can have a harmful effect upon the emulsion.

For a negative to dry, it must be surrounded by dry air; that is, air that contains a lower relative percentage of moisture than the gelatin. When the heated air circulates, the damp air moves away from the surface of the wet film and replaces it with dry air that permits the drying process to continue. This is the principle behind the air impingement dryers currently in use. Heated air accepts more moisture than cool air. When the air does not move, air can become heated and rapidly reach a state of equilibrium with the moist film, and drying stops.

In an air impingement drying system, air is warmed and blown against (impinges upon) the surface of the wet film. The warm, dry air picks up moisture and moves on. It is immediately replaced by more warm, dry air, and the process continues until the film is dry. The rate of drying is controlled by adjusting the velocity, temperature, and humidity of the air in the drying chamber. In hot and humid climates where the air is saturated with moisture, the air must be passed through a dehumidifier before it enters the drying chamber. When this is not done, the film does not dry. In dry climates, you must reduce both the heat and the air velocity to prevent overdrying.

Photographic films begin drying at the corners and edges as well as in the areas of heaviest density. This introduces strains in the direction of the dry areas. As a film continues to dry, the strains gradually begin to equalize, and the film, when dried properly, ultimately lies flat. The surface is not moist to the touch, but it is firm and soft enough that flexing does not damage it. If overdried, the film curls toward the emulsion and can become brittle.

The rate of drying and the amount of curl also depend upon how thick the emulsion layer is and whether or not the film has a gelatin backing. Naturally, the thicker the layer, the longer the drying time. A gelatin backing takes time to dry, but it introduces an opposing curl and causes the dried negative to lie quite flat.

FILM PROCESSING EQUIPMENT

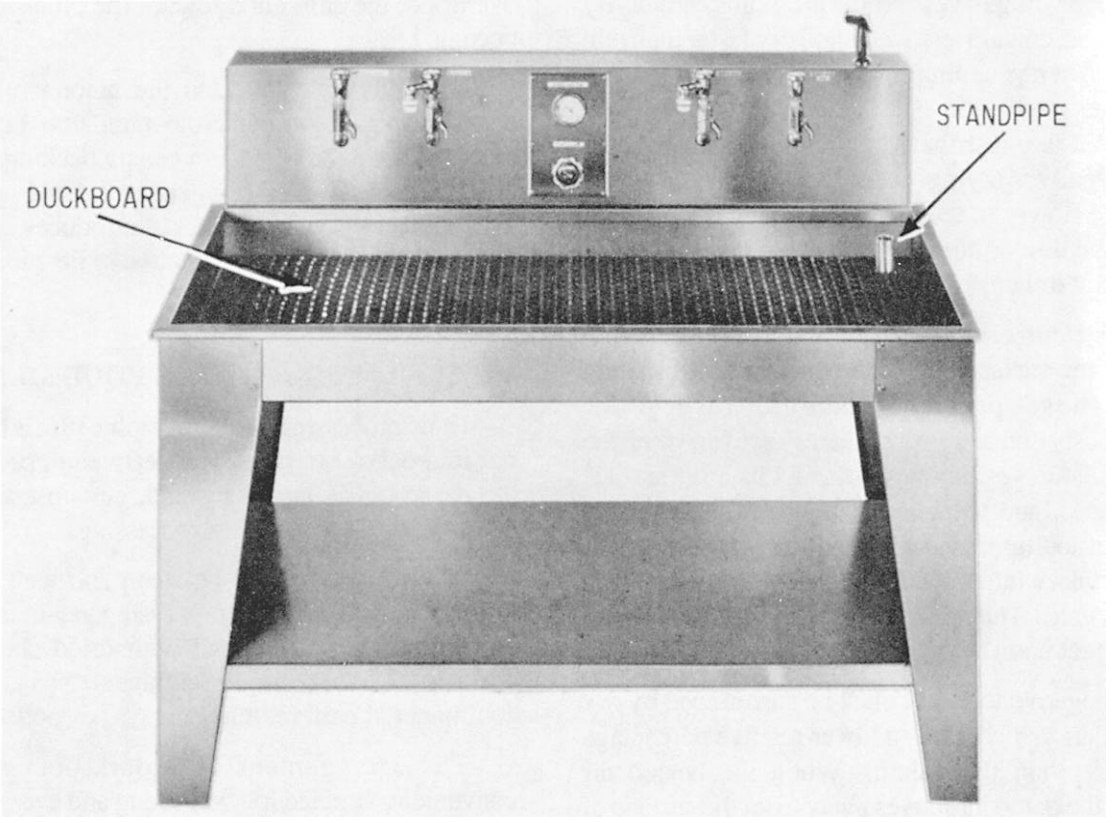
Hand processing of photographic film is best carried out in a darkroom that is properly equipped. Whether the darkroom is large or small, certain essentials are necessary for good quality processing.

The darkroom must be clean and well ventilated. Shelves, bottles, racks, processing equipment, walls, and floors that are spotted with dried chemicals are harmful to photographic images. Navy photo lab equipment, therefore, must always be spotlessly clean.

The arrangement of a darkroom should be convenient, "a place for everything and everything in its place." There should be adequate and correct safelights placed at recommended working distances. Only necessary sensitized material should be in the darkroom. Temperatures in the lab should be maintained as closely as possible to the normal processing temperature-about 70°F to 75°F. The well-equipped darkroom should contain the following items: sink, graduates, required chemicals, waterproof aprons to protect clothing, clean towels, accurate thermometer and timer, and the necessary film hangers, trays, reels, and tanks. All darkrooms should be well stocked with prepared chemicals in containers that are labeled properly. In general, good photographic quality demands that all work must be conducted in a clean, orderly, and systematic manner.

DARKROOM SINKS

Sinks in the photographic darkroom should be sized adequately and constructed properly. Most sinks in Navy labs are factory-made and meet all the requirements for photographic work Sinks should be big enough and built so they drain thoroughly. The sink should have *duckbords* to keep trays and tanks off the bottom and to permit water to circulate under and around the solution tanks to maintain correct and constant temperatures. Sinks, also, should have a mixing valve to control the temperature of the water in the sink and a



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Figure 10-1.–Photographic processing sink

standpipe to hold water in the sink at the correct depth, yet still allow water to flow out (fig. 10-1).

SAFELIGHTS

The function of a safelight is to transmit the maximum amount of light that can be used safely without damaging the sensitized materials being processed. The color sensitivity of different sensitized materials varies. Therefore, the color and intensity of transmitted light must be varied accordingly. A darkroom safelight is the combination of a rated light source and a filter designated to protect a specific sensitized material.

The word *safe.* of course, is a relative term since no sensitized photographic materials are ever completely safe from the effects of safelight illumination. However, a filtered light is accepted as safe when the sensitized materials can be handled under the illumination with no evidence of fogging for at least twice as long as the normal processing time. No procedures must be followed precisely when safelights are used:

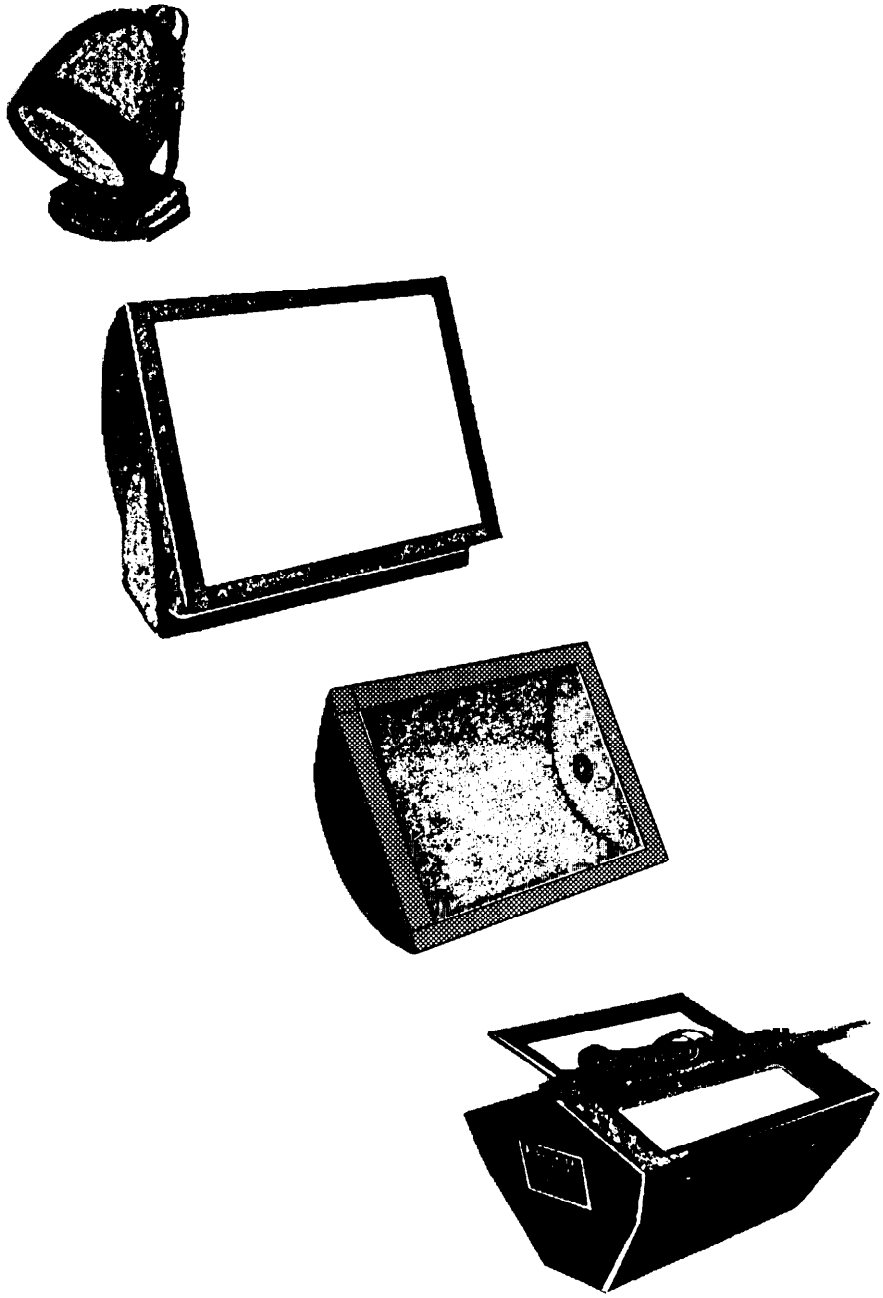
- Use only the size of incandescent bulb specified; for example, 7 1/2 watt, 15 watt, or 25 watt.
- Handle sensitized material at the distance recommended by the manufacturer. This is usually between 3 and 6 feet.

To determine whether a safelight is safe, you should follow these procedures:

1. In the dark, place a sheet of unexposed film, emulsion-side up, on the working area where the film is to be processed.

2. Place several coins on the emulsion and turn on the safelight. Leave the safelight on for twice the length of time the film will normally be processed.

3. Process the film normally and check to see whether there is less density in the areas covered by the coins. When there is less density, it indicates the film was fogged by the safelight and the safelight is not safe. A safelight that causes fogging may be corrected by replacing the filter, by installing a lower rated bulb, or



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Figure 10-2.–Safelights.

by increasing the distance between the safelight and the material. Safelight filters are covered in chapter 3.

A safelight is most efficient when its output of illumination is indirect or reflected. When the safelight is not constructed on the indirect principle, it should never be pointed directly at the sensitized material; it should be placed so the light beam is away from or at an angle to the sensitized material. Figure 10-2 shows safelights used in photographic darkrooms.

SHEET FILM HANGERS

Sheet film hangers are made of stainless steel or plastic that resist corrosion in photographic solutions

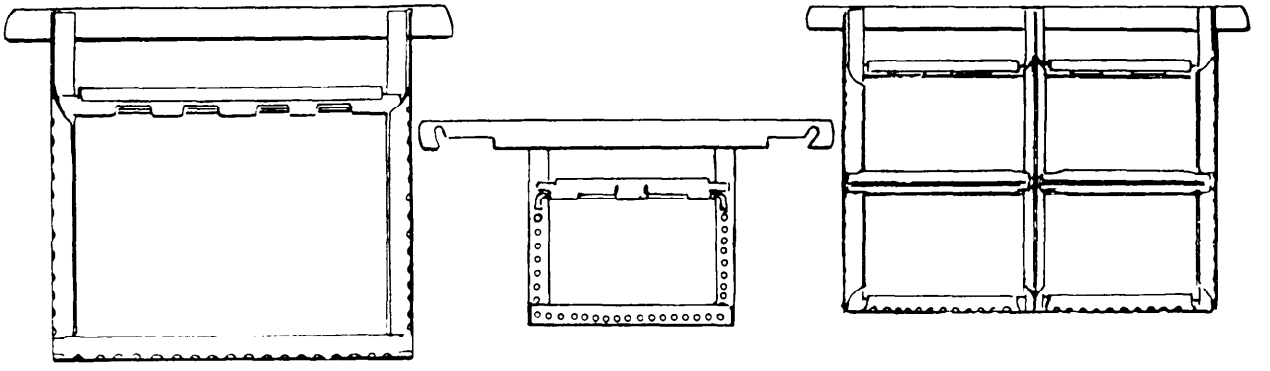


Figure 10-3.–Sheet film hangers.

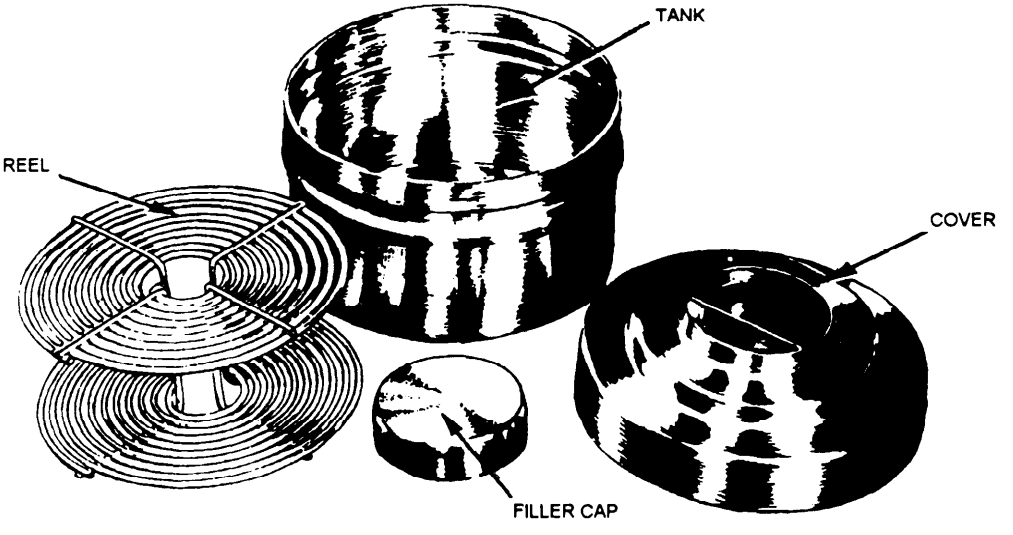


Figure 10-4.–Roll film processing tank and reel.

(fig. 10-3). They are constructed of perforated metal or plastic and channeled to receive and suspend film in solution. This allows the solution to circulate freely over the film surface. Sheet film hangers are used in tank developing and their use is described later in the this chapter.

ROLL FILM TANKS AND REELS

Hand processing of roll film is usually done on reels in roll film tanks. The center-feed reel and tanks used most commonly in the Navy are made of stainless steel. The film is wound onto a spiral reel. The reel is then placed into a tank for processing (fig. 10-4).

TRAYS

Trays used for processing photographic film (roll or sheet) are the same as those used for processing photographic prints. They may be made of any material that is not affected by, or cause contamination of, photographic solutions. Most trays used today are made of stainless steel or plastic.

SHEET FILM DEVELOPING TANKS

Tanks used for developing sheet film come in a variety of shapes and sizes. They are usually made of stainless steel.

To process sheet film in tanks, load the film into sheet film hangers and then place it into the developing tanks of solutions (fig. 10-5).

FILM WASHING EQUIPMENT

Film washing does not require special equipment. Sheet film can be washed in the same type of tank or tray that is used to process the film or in tanks designed for film washing.

When a tray is used, only one film at a time should be washed. When more than one piece of film is washed at a time, the films will probably rub together and be

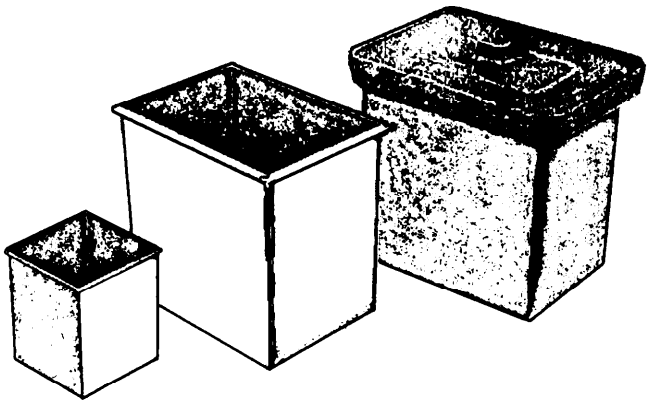


Figure 10-5.–Film developing tanks.

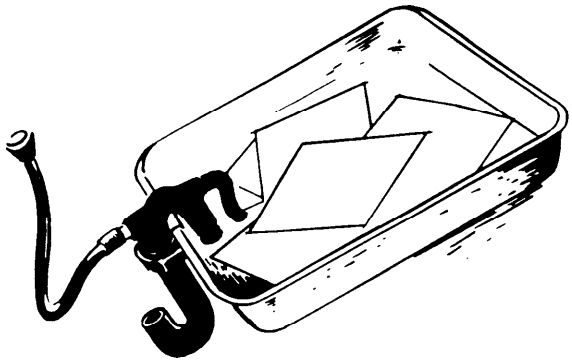


Figure 10-6.–Washing film in trays.

scratched. Only line copy types of negatives are usually washed in a tray.

The most effective washing method in a tray is when a siphon device is attached to the edge of the tray. The device siphons water from the bottom of the tray, while fresh water enters at the top (fig. 10-6). Because fixer is heavier than water, it sinks to the bottom of the tray.

The best way to wash hand-processed sheet film (especially more than one sheet at a time) is in a sheet-film washing tank. Film hangers hold individual negatives suspended separately in the tank. Fresh water flows into the bottom of the tank and runs out around the sides at or near the top of the tank (fig. 10-7). When you place the film hangers into the tank, ensure the negatives are separated, so sufficient fresh water reaches all areas of each negative.

WARNING

Aboard ship, hoses attached to potable water spigots can back siphon chemicals or wash water from the trays or sink into the drinking water supply. These hoses must have a backflow preventer installed in the plumbing system.

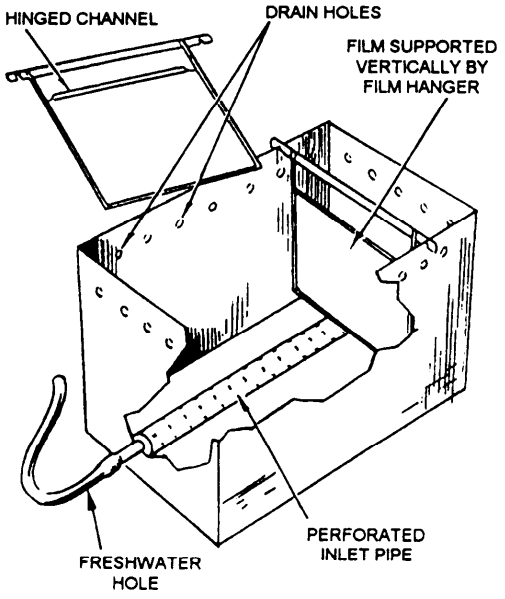
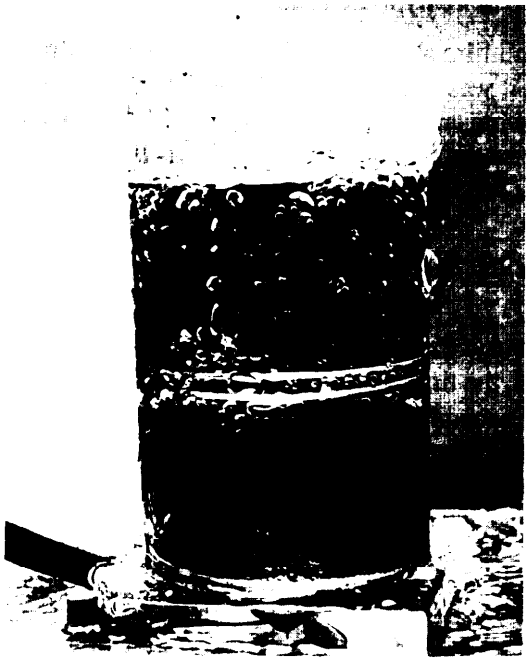


Figure 10-7.–Film washing tank



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Figure 10-8.–Rapid roll-film washer.

A rapid roll-film washer is excellent for washing hand-processed roll film. It is a cylindrical tank, large enough to hold several spiral reels. The washers come in a variety of sizes that will wash from two 35mm reels to as many as six or eight 120 reels (fig. 10-8).

The rapid roll-film washer is constructed so the wash water enters the tank at the base and flows up

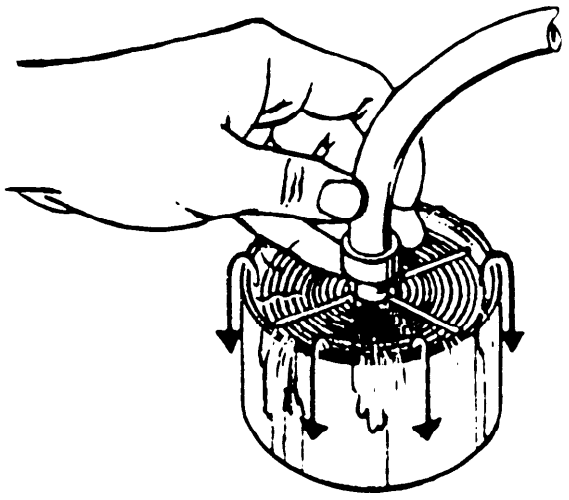
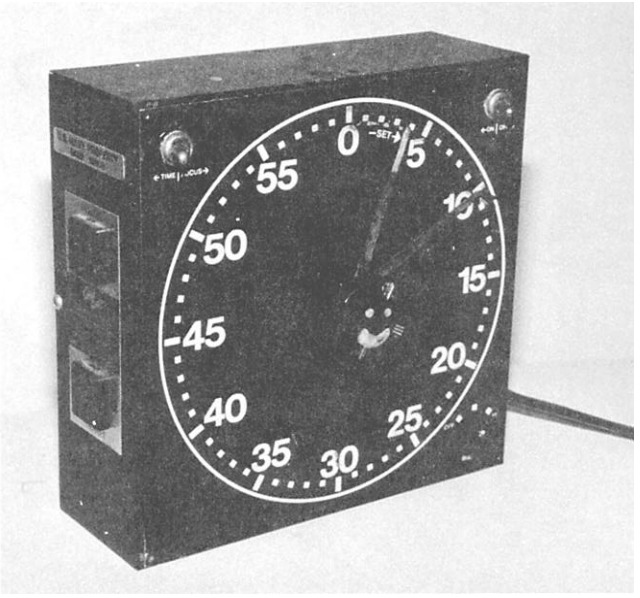


Figure 10-9.–Washing film in processing roll-film tank.



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Figure 10-10.–Gray Lab timer.

through the tank and around the film at a rapid rate. By discharging the water from the top of the tank, you can remove more hypo in a shorter time.

Roll film also can be washed in the roll-film tank in which it was processed. To wash roll film in a roll-film processing tank, simply push a small hose down into the center of the reel and have the faucet turned on, so the water overflows steadily from the tank (fig. 10-9).

TIMERS

Every darkroom should have a reliable timer. Ideally, the timer should have both a minute hand and a sweep second hand. The timer most commonly used in the Navy is a Gray Lab timer (fig. 10-10). Not only does this timer have a minute and sweep second hand but the numbers and hands are fluorescent so they can be seen in the dark A Gray Lab timer also has an alarm (buzzer) that indicates when the time for processing is up.

PROCESSING METHODS

No matter how many rolls or sheets of film you develop, it helps when you carry out the processing in three distinct phases, beginning with preparation. First, your work area must be clean, and the equipment needed must be arranged so it is easy to locate in the dark The second phase is processing. If you are not familiar with darkroom work, you should complete ALL the processing steps with dummy or practice film and water to substitute for processing solutions under white light and then practice a few times in the dark. The third phase is film drying.

To make the latent image visible and permanent, you must process the film in different chemical solutions. There are five steps in the black-and-white processing phase. The first step is development. In this step the film is placed in a developer that transforms the latent image into a visible black metallic silver image. In the second step the developing solvents are neutralized, and development is retarded or stopped by a rinse bath or acid stop bath, respectively. The third step involves placing the film into a fixing bath to remove the light sensitive, undeveloped silver halides. The fourth step is to wash the film to remove all the chemicals, and the last step is to dry the film. Each of these steps is explained further in this chapter, since there are certain controls that must be applied to each step.

Some of the processing steps may be carried out in white light, while others *must* be done under appropriate safelight conditions or in total darkness. The steps that must be done in darkness or under suitable safelight conditions begin when the film package, holder, or roll is opened and end when the film is removed from the fixer.

As discussed earlier, there are five steps in film processing. The steps and the lighting conditions under which they are carried out are as follows:

1. Development-dark or appropriate safelight
2. Rinse or stop bath-dark or appropriate safelight

3. Fix-dark or appropriate safelight

4. Wash-white light

5. Dry-white light

In addition to exposure, there are four factors in development that control image density, contrast, and, to a limited degree, the uniformity of individual densities in a negative. These four factors are the type of developer used, development time, temperature of the developer, and agitation as follows:

- Type of developer. One type of developer cannot cover all film exposure/processing situations. For example, film exposed under poor lighting conditions may require a vigorous developer to bring out as much image detail as possible, while film exposed under normal conditions requires a normal working developer. There are many different developers, each provides a different activity and quality of development. The actual choice of the developer to use depends on the following: the type of film, conditions under which it was exposed, type of negative required, developing time that is best for the method of development to be used, and the manufacturer's recommendation.

- Time and temperature. Many factors must be considered if you want to ensure correct development during film processing. Two of these factors are the length of time the film is allowed to develop and the temperature of the developer solution. Both factors can have a significant impact on the quality of the processed film.

As explained earlier, the activity of a developer increases as its temperature increases. Film development carried out for a given time at a given temperature produces both predictable and desired results-assuming, of course, that the film has been exposed properly. When film is developed for a given time at a given temperature, it is called "time and temperature development."

In the time and temperature method of film processing, as in any method of film processing, if the film is developed for too short a time or at too low a temperature, a weak, low-contrast image results. Underdevelopment can result in insufficient highlight density. On the other hand, if the negative is developed for too long a period or at too high a temperature, the result is a negative having too much density. The developer solution overdevelops the exposed areas and may even develop some of the unexposed silver halides.

For correct development, both time and temperature must be accurately controlled. Within limits, time can be adjusted for a given temperature, or temperature can be adjusted for a given time.

There is a definite correlation between time and temperature. When it is impossible to maintain solution temperature at the desired level, time can be shortened or lengthened to compensate. As the temperature increases, developing time must be decreased to provide equivalent development. As the temperature decreases, development time must be increased.

The normal temperature for hand processing most black-and -white film is 68°F (T-Max film with T-Max developer is 75°F). There are several reasons for this standardization. At a temperature of 68°F, the gelatin swells sufficiently to allow adequate penetration of the developing solution without oversoftening to the point where it is easily damaged (which occurs at higher temperatures). Temperatures lower than 68°F slow development excessively. Only when time is of the utmost importance are accelerated temperatures used. In most instances when high temperatures are used, the film is treated in a hardening bath before processing, or the film is designed specifically for being processed at such temperatures. Since a rise of several degrees in temperature shortens development only a small amount, there is little to be gained by deviating from standard processing temperatures.

When you know the time and temperature relationship for a given film and developer combination, processing in total darkness becomes simple. You simply adjust solutions to the prescribed temperature and then process the film for the required time. Assuming proper exposure, time and temperature processing can produce a correctly developed negative without your having to see what is happening in the solution.

All solution temperatures (developer, rinse, fix, and wash) should be as close to each other as possible. When there is considerable difference in the temperature of the solutions, excessive graininess may result, or the emulsion may be subject to excessive expansion and contraction that causes it to wrinkle or crack This effect is called *reticulation.* Since reticulation is not correct-able, it causes the negative to be useless for printing.

The temperature of solutions may be adjusted by surrounding them with hot water, cold water, or ice. Never add water or ice directly to a solution because it dilutes the developer to an unknown degree. Ice may be placed in a container and suspended in the solution. An immersion heater may be used in the solution to raise its temperature.

- Agitation. If a film is placed in a developer and allowed to develop without movement, the chemical action soon slows down because the developing agent in contact with the surface of the emulsion becomes exhausted and bromide (a restrainer) is released as a by-product. When the film is agitated, however, fresh solution is continually brought to the surfaces of the film, and the rate of development remains constant. Therefore, agitation also has an important effect on the degree of development. An even more important effect of agitation is it prevents uneven development. If there is no agitation, the exhausted solution that became saturated with bromide from the emulsion may flow slowly across the film from the dense highlight areas and produce streaks. Constant agitation is usually recommended for the first 30 seconds of tank development and for the entire developing time when the film is being processed in a tray. After the initial 30-second agitation cycle, the film should be agitated for 5 seconds, once every minute during the remaining time.

The time, temperature, and amount of agitation required for a film/developer combination are recommended by each manufacturer of film or developer. These recommendations are in the instructions that accompany the film or developer. Another reference source is the *Photo-Lab-Index.*

There are three different methods of processing film by hand. These are as follows: the *tray,* the *sheet-film tank,* and the *roll-film tank.* Each method is discussed here with an example of the darkroom arrangement used.

TRAY PROCESSING

The tray method is used primarily for processing only a few sheets of film. With a lot of experience, you can process as many as 6 to 12 sheets of film in a tray at one time. You will find it easier to work with only a few sheets of film at a time, and repeat the process, than to start all the sheets at the same time and damage them.

The tray processing method described here has proven satisfactory under most conditions for processing one sheet of film at a time. You should use this method as described and develop the necessary skill using this procedure before you attempt to use variations.

The trays should be considerably larger than the film being processed; for example, 4x5 film should be processed in 8x10 trays, 8x10 film in 11x14 trays, and 11x14 film in 16x20 trays. Ideally, the trays should be arranged in a shallow sink that contains temperature-controlled circulating water. The trays should be arranged with the developer to your left as you face the trays. The stop bath goes next to the developer, followed by the fixer and the wash tray.

In all Navy imaging facilities, it is standard procedure when processing film (or prints) by hand to work from left to right.

Rinse the trays with fresh water as a precaution against contamination, and prepare the solutions. When the solutions are ready, place the exposed film holder to be unloaded on a clean, dry area of the workbench near the developer. Set the timer for the correct developing time, and place it in a convenient location near the processing solutions. Then, if you are processing panchromatic film, turn out all the lights. If you are processing monochromatic or orthochromatic film, you can use a suitable safelight.

Remove one sheet of film from the holder and submerge it quickly, emulsion-side down, into the developer. Then immediately turn it over (emulsion-side up) and slide it back under the surface of the developer quickly, and agitate it vigorously to eliminate possible air bubbles. The surface of the film must be wetted quickly and evenly; otherwise, developing marks may result. Start the timer just before the film is placed into the developer.

During tray development, the tray should be rocked continuously to provide constant agitation. Be careful that the tray rocking is not too fast and that it is varied at intervals; for example, first front to back, and then side to side to avoid patterns of uneven development caused by regular waves.

CAUTION

Do not allow your fingernails to touch the film emulsion at any time.

Tray development involves constant agitation, and development time is usually about 20 percent less than if the same film were being developed with intermittent agitation. When tray agitation is done very slowly, the agitation should be considered intermittent and the developing time adjusted accordingly.

When the timer rings, remove the film from the developer, drain it from one corner, and submerge it in the stop bath. Agitate the film in the stop bath for about 5 seconds; then transfer it to the fixer. You must agitate

the film vigorously in the stop bath and initially in the fixer because gases are released in these solutions and there is danger of air bubbles forming on the film surface. If you allow these air bells, or bubbles, to form, they may cause dark spots. This is due to the continued action of the developer beneath the bubbles. Agitate the film in the fixing bath for a few seconds and then the safelights or the white lights may be turned on. Continue agitating the film until it loses the cloudy or creamy appearance. Note the time required for this change to occur because it is just half the total required fixing time. Agitate the film several times during the second half of the fixing time. After the film clears, continuous agitation is not necessary.

After fixing is completed, transfer the negative to the wash water and continue to agitate it unless a regular film washing tank or tray is available. After washing is complete, the film should be treated in a wetting agent and dried.

As stated earlier, with experience you can process several sheets of line copy film at a time in a tray. When processing several sheets in a tray at once, there is an added step. This is a predevelopment rinse in clean water that should be at the same temperature as the rest of the processing solutions. The predevelopment rinse is located to the left of the developer. Its purpose is to prevent the films from sticking together in the developer.

The procedure for processing more than one sheet of line copy film at a time is the following:

1. When the solutions are ready, place a dry, dust-free paper or cardboard on the workbench near the predevelopment rinse. Place the exposed film holders near this clean working space.

2. Set the timer.

3. Turn out the lights.

4. Remove one film from its holder and place it, emulsion-side down, on the clean paper. Remove the second film and place it, emulsion-side down, on top of the first. Continue until all the film is placed in a loose pile on the space provided for them.

5. Pick up the film on top of the pile with your left hand (keep it dry until all films have been placed in the water), drop it, emulsion-side down, into the water, and immerse it quickly with your right hand. Pick the film up immediately, turn it over, emulsion-side up, and push it back under the solution. Place the wet film, emulsion-side up, at one end of the tray. Immerse the next film in the same manner. Stack it on top of the first film, and continue with this procedure until all the films are stacked in a pile at one end of the tray. Your left hand should follow the last film into the tray to assist in the agitation of the films.

Wet film may be handled with wet fingers. However, be extremely careful to KEEP WET FINGERS OFF DRY FILMS. Slight pressure with the balls of the fingers is not harmful to a wet emulsion unless it has swollen excessively.

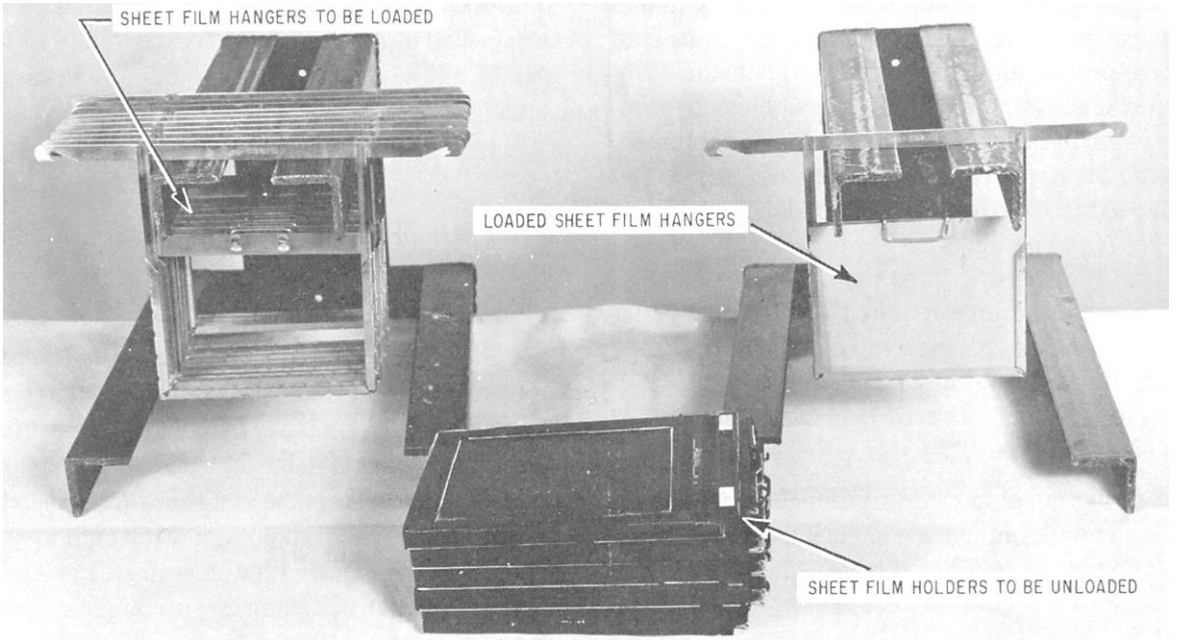
The films should be agitated or shifted constantly to prevent the individual sheets from sticking together. Agitation is accomplished by moving the first film from the bottom of the stack and placing it on top or by starting a new stack at the other end of the tray. Continue agitating the films from bottom to top until they become completely saturated with water-about 1 or 2 minutes is sufficient. After the emulsion is completely saturated, the danger of films sticking together is no longer a problem.

6. Remove the films, one at a time, from the predevelopment rinse and immerse them in the developer. Place the films in the developer, emulsion-side up; slide them under the surface of the solution quickly, and agitate them vigorously to eliminate possible air bells. Start the timer just before the first film is placed in the developer. Use your left hand to remove all films from the water, and be careful not to get the water contaminated with developer. Your left hand should follow the last film transferred from the water into the developer to help with the agitation.

It is important for you to locate the first sheet of film placed in the developer quickly. To do this, align the long dimension of all other films at a right angle to the first sheet placed in the developer.

The films are immersed, emulsion-side up, in the developer to reduce greater damage that would occur if the emulsion, already softened by presoaking, were allowed to come in contact with the bottom of the tray. Be careful not to dig or drag the comer or edge of a film into the emulsion surface of the film below it. Do not allow your fingernails to touch the emulsion at any time. Stacking films by aligning their edges against the sides of the tray helps to reduce scratches and abrasions.

7. Agitate the films constantly, not by rocking the tray, but by moving each film from the bottom of the stack and placing it carefully on top, and pressing it down gently to assure a flow of solution over its surface. Continue this procedure until the developing time is up.



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Figure 10-11.–Sheet film hangers arranged for tank processing.

8. When the timer rings, remove all the films from the developer in the same order that they were placed in the developer, and submerge them in the stop bath. Your right hand should go into the stop bath with the first film and stay there to handle each film as it is transferred from the developer by your left hand. Use your left hand only for transferring the film to avoid contamination of the developer or spotting of the film. A few drops of developer will not affect the stop bath or the fixing bath, but a few drops of either of these solutions could rum a developing solution.

9. After all the films have been shifted several times in the stop bath, they should be transferred individually to the fixing bath or hypo. Shift the films several times in the fixing bath, agitating them vigorously. Then safelights or the white lights may be turned on. Continue shifting the films until they lose the cloudy or creamy appearance. You must shift the films several times during the second half of the fixing time, but continuous agitation is not necessary.

10. After fixing is completed, transfer the negatives to the wash water and continue agitation unless a regular film washing tank or tray is used. The negatives also may be put in regular film hangers for washing.

11. Treat the film in a wetting agent and dry it.

TANK DEVELOPING SHEET FILM

Tank development is the recommended method for hand processing of orthochromatic and panchromatic sheet film. The solutions and the tanks are deep enough to cover the films in the vertical position completely. The films are supported individually in the tanks by the film hangers. Films supported in this way are much less subject to damage. The solutions last longer when used in tanks and can process more films than when they are used in trays.

Tank development for sheet film requires tanks to hold the solutions, and racks, reels, or hangers to support the films while in the solutions. The solutions used should have good-keeping qualities, and they should be the type that can be replenished by adding fresh solution or replenisher, so the volume in the tanks can be maintained at the proper working level.

The minimum number of tanks that can be used is three: one each for developer, stop, and fixing bath. However, when a predevelopment rinse is used, four tanks are needed.

The tanks are arranged in the processing sink submerged in enough water to maintain the solutions at the prescribed processing temperature. Again the process is arranged so you work from the left to right.

The film hangers are simply channeled frames suspended below a bar. The bar is long enough to reach across the tank and allow the frame to hang below the surface of the solutions. The frame has channel pieces on the bottom and both sides and a hinged channel across its top. Each hanger holds from one to four films. The hangers accommodate standard film sizes, such as 4x5, 8x10, and so forth. After the films are loaded into the hangers, they may be carried through the entire process without being touched by the hands.

The darkroom should be checked using the steps common to all film processing, as explained earlier in this chapter. After you check the solutions and their arrangement, check the temperature of the solutions, and check the safelights. Then arrange an adequate supply of clean, dry, empty film hangers on a rack, and an empty rack to hold the loaded film hangers (fig. 10-l1). If the darkroom is not equipped with racks to hold the film hangers, clean, dry tanks can be used to hold both unloaded and loaded hangers. Set the timer, place the exposed film holders between the empty film hangers and the rack or tank that is used to hold the loaded hangers, and turn out the lights.

To load a sheet film hanger, remove one of the sheet films from its *holder*. Take a *hanger* in one hand and place the thumb at one end of the hinged channel. Bush the hinged channel up and back with the thumb until the film can be slid along the inside of the end channels to the bottom of the frame. HANDLE THE FILM BY THE EDGES ONLY. Make sure the film is seated properly in the three channels of the hanger. When the film is seated properly in the side and bottom channels, bring the top channel forward and down over its top edge (fig. 10-12). This encloses all four sides of the film in the channeled frame. The hanger should be given a slight shake to ensure that the film is in place. Set the loaded hanger on the rack or in the empty tank to hold it.

The film should be loaded onto the hangers with the emulsion side facing you. This prevents the top channel from scratching the emulsion as the film is slid into the frame. Load the other film to be developed in the same manner. However, do not load more hangers than can be handled conveniently in the tanks at one time.

When the hangers are loaded, lift all of them by their crossbars and lower them into the predevelopment water rinse, if one is being used. They should be lowered into the tank until the hanger crossbars rest on top of the tank The predevelopment water rinse is optional when using the tank method of development, but the water rinse has the following advantages:

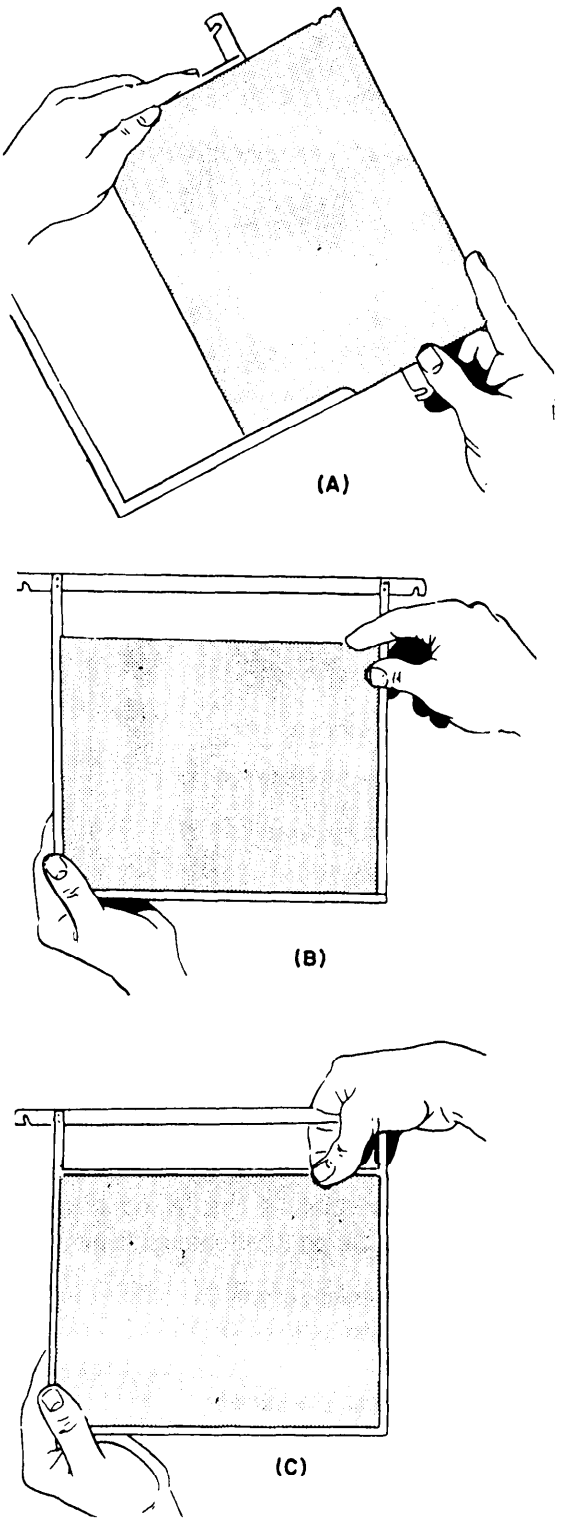


Figure 10-12.–Loading a sheet film holder.

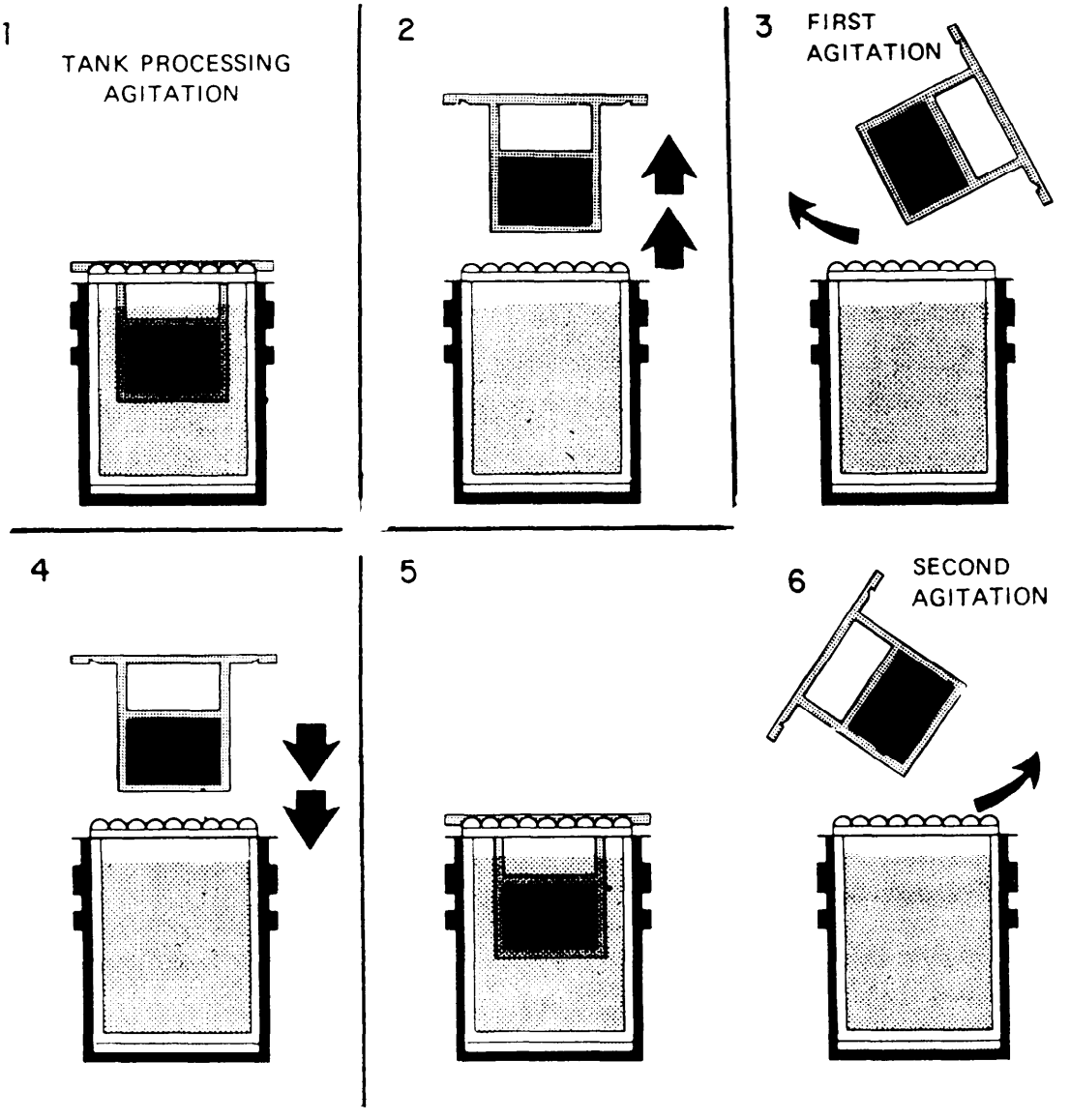


Figure 10-13.–Sheet film tank processing agitation.

- The air bubbles that usually occur when dry film is immersed in a solution can be removed without harmful effects in the predevelopment water rinse.

- When the water-softened emulsion is placed in the developer, the action of the solution begins uniformly over the entire emulsion. Thus uneven or streaky development is avoided.

- The predevelopment water rinse removes the antihalation backing dye that interferes with the action of some developers.

- The predevelopment water rinse brings the temperature of the film and the hangers to the processing temperature. Maintaining constant temperatures in all of the processing solutions is very important.

The predevelopment water rinse is given by immersing the loaded hangers in a tank of water and agitating them for about 2 minutes. The temperature of the water should be the same as that of the other processing solutions. The loaded hangers are then lifted out of the water, drained by one comer, and processed in the usual manner.

Immerse the hangers in the developer slowly and smoothly to avoid splashing or the formation of air bells. Air bubbles usually result when films are immersed rapidly, especially when a predevelopment water rinse was not used. All the hangers should be immersed simultaneously to assure uniform agitation and development.

Strike the hangers sharply against the sides of the tank several times to dislodge any air bubbles that may

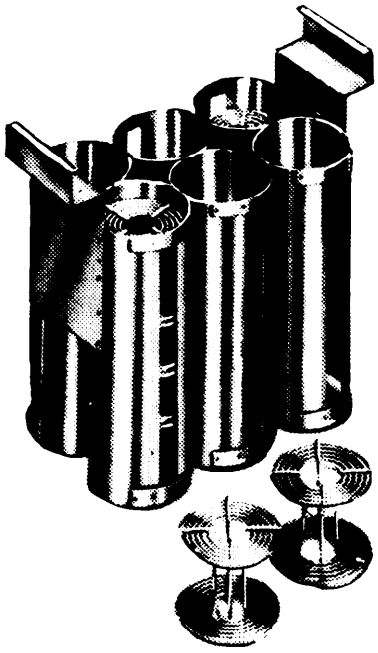


Figure 10-14.–Reel processing rack.

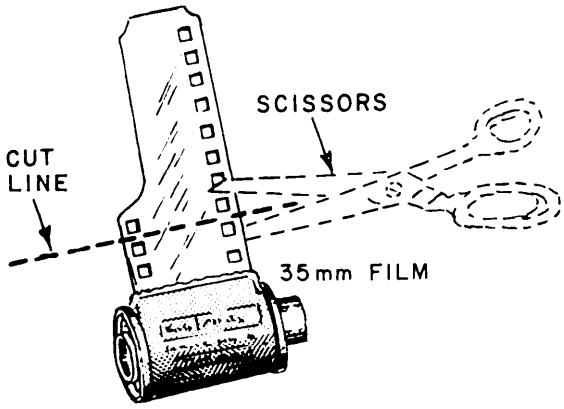


Figure 10-15.–Cutting leader tab film 35mm film.

have formed. Start the timer and agitate the film for 1 minute. After the first minute of development, agitate for 5 seconds at l-minute intervals.

The processing tank usually has enough space for several additional hangers. However, this space is needed for proper agitation of the film hangers. Agitation should be accomplished by lifting the hangers out of the tank draining them momentarily from a different comer each time, and replacing them in the solution (fig. 10-13). Hangers should not be agitated too vigorously from side to side. This forces the developer through the holes in the hangers at high speed, causing developing trails near the holes. The objective is to assure an even flow of fresh solution over the surfaces of the films regularly according to a fixed schedule.

About 10 seconds before completion of the developing time, lift each of the hangers out of the solution, let them drain for 10 seconds, then lower them into the stop bath. Agitate them several times in the stop bath, drain them, lower them into the fixing bath, and agitate them constantly for 2 or 3 minutes.

The fixing and the washing requirements are the same as described previously in this chapter. When washing is complete, place the film hangers and film into a wetting agent; then remove each sheet from its hanger and hang it up by one corner to dry.

When the film is dried in the hangers, there is a number of drying marks along the edges of the film, thus reducing the actual usable size of the negative image. It is better to suspend each film individually from a line with a film clip. Dry the hangers, *after washing them in hot water,* without film in them.

With suitable racks designed to hold reels, roll film can also be processed in tanks (fig. 10-14).

TANK DEVELOPING ROLL FILM

The most convenient and reliable way to hand process roll film is in a small roll-film tank. The construction of tanks and reels differ somewhat among the various manufacturers' models, resulting in differences in loading and use. Generally, the basic unit used in Navy imaging facilities consists of a stainless steel, center feed, spiraled reel to hold the film; a tank with a lighttight cover; and a filler cap. Each reel is constructed for a specific size roll of film; for example, 35mm, 120, and 220. The tank top permits pouring the chemicals in and out of the tank under white light conditions. The tanks come in sizes to hold from one 35mm reel to as many as eight 35mm reels or five 120 reels. Small roll-film tanks of all metal construction (tanks, lids, caps) should be numbered or marked in such a way that prevents mixing different tanks, lids, and caps.

The proper loading of a film reel *in total darkness* can be the most important steps and challenges in processing roll film.

When processing roll film with a paper backing, the paper tape sealing the exposed roll should not be broken until the lights have been turned out. Also, for 35mm film, the cassette should not be opened until the lights have been turned out. If a short length of film is left protruding from the 35mm cassette when the film is rewound, you do not have to open the cassette to remove the film. The leader or loading tab on 35mm film can be cut off square while in the light to ease loading of the spiral reel (fig. 10-15).

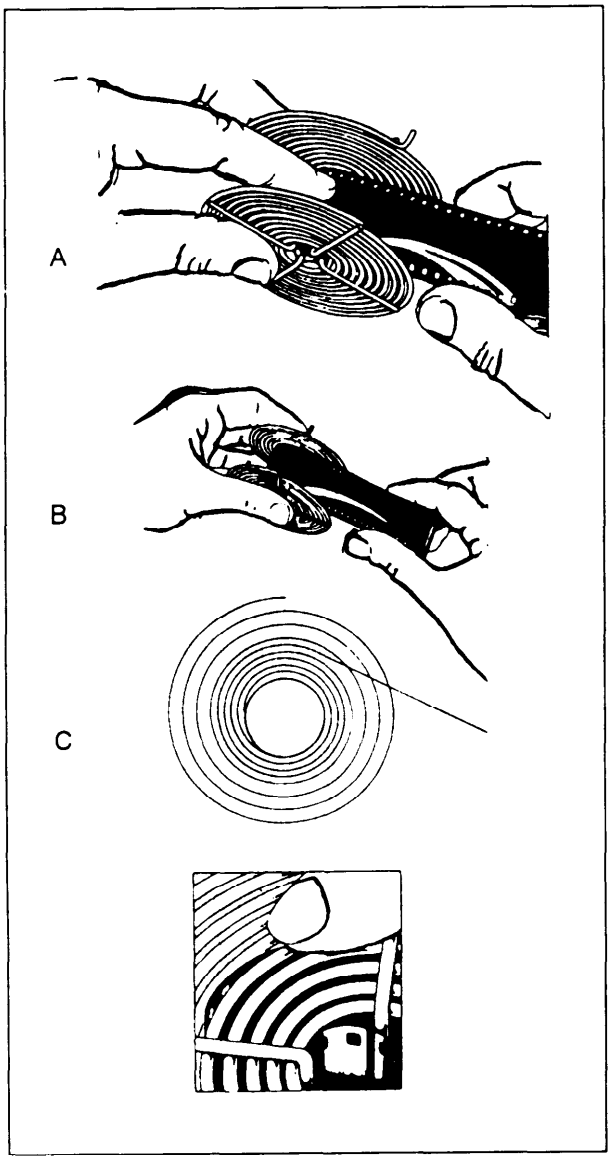


Figure 10-16.–Leading 35mm film on wire reel.

There are three ways of loading a center-feed spiral reel. You should practice each method (with a dummy roll), both in white light and in total darkness, and select the method that is most comfortable for you. Then perfect that method. Although the three methods are similar, there are differences that may make one method easier for you. However, before beginning one of these methods, make sure that both the reel and your hands are clean and dry.

- First method. Remove the film from the cassette (35mm) or separate it from the paper backing (120 or 220). The film must be handled only by the edges to prevent scratches and fingerprints. (When you work with 35mm film, the tongue of the leader must be cut off to make a square end before loading the reel.)

If you are right-handed, the ends of the wire spiral must be positioned on the top and pointing to the right (fig. 10-16, view A). For left-handed people, the ends of the wire spiral reel when positioned at the top must point to the left.

Next, bow the film slightly concave to clear the edges of the spiral and clip or hold the film to the core (center) of the reel (fig. 10-16, view B). The film emulsion must face in or toward the reel center. The tension on the film should be firm enough to prevent the film from skipping the spiral grooves, but not so firm it overlaps or falls into the same groove twice.

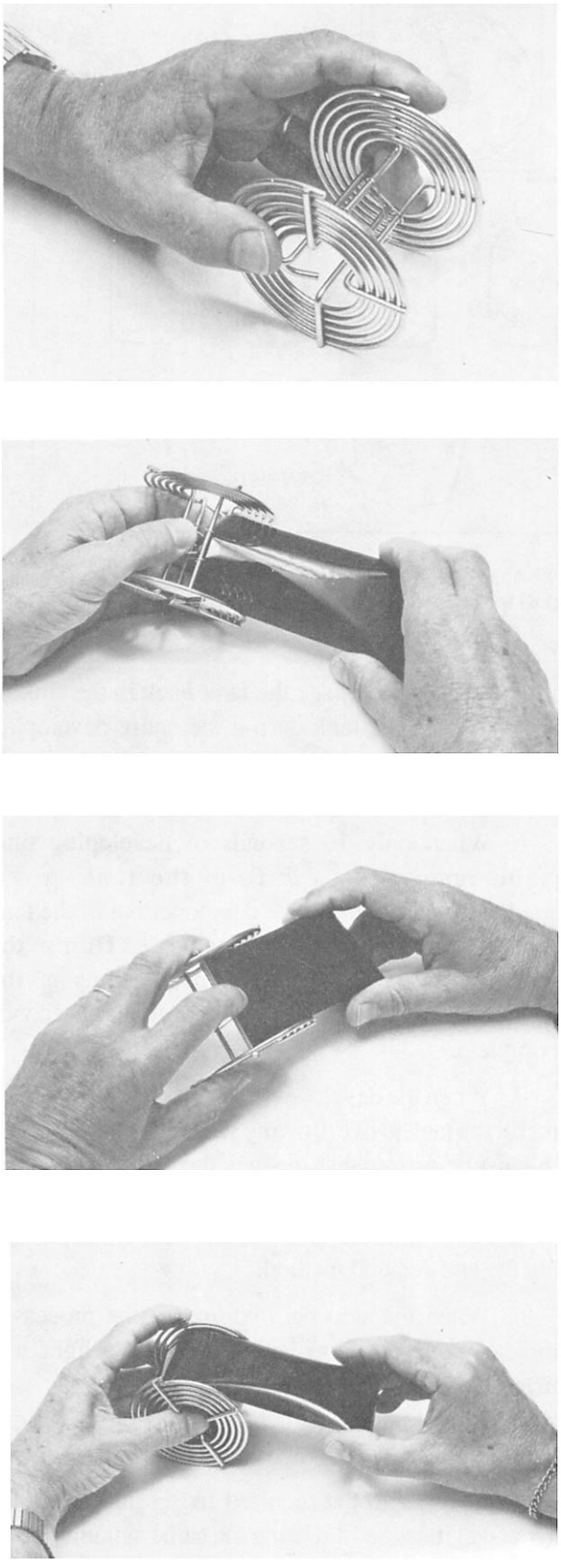
Turn the reel, apply gentle pressure, and keep your thumb and forefinger on the film edges. This pressure produces a slight curl in the film and allows it to pass onto the edges of the reel. As you continue to turn the reel, the film straightens out and fits into the grooved spaces in the reel (fig. 10-16, view C). Apply enough tension to the film so it does not skip grooves. However, too much tension may cause the film to overlap in the same grooves of the reel.

- Second method. Prepare the film as before. Hold the reel to be loaded on a clean working surface in your left hand with the ends of the wire spiral at the top, pointing toward the right (fig. 10-17, view A). If you are left-handed, hold the reel in your right hand with the ends of the spiral wires at the top, pointing toward the left.

Hold the film by its edges in your right hand and bow it between your thumb and forefinger. With your left index finger or thumb, depress the grip clip and gently push the end of the film into the core of the reel (fig. 10-17, view B). When the reel does not have a grip clip, insert the film end about 1/4 to 1/2 inch into the reel core and hold it there with your left thumb and index finger (if right-handed). Remember, always load the reel with the film emulsion facing in, or toward, the reel core. Be sure the film is held straight at the reel center (fig. 10-17, view C).

Now turn the reel smoothly in a counterclockwise direction with your left hand, and guide the film into the spiral grooves with the thumb and forefinger of your right hand (fig. 10-17, view D).

- Third method. Slowly unwind the paper backing from the film until you feel the film with your finger. Do not completely unwind the paper backing from the film.



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Figure 10-17.–Loading 120 film on reel.

For 35mm film, if the film was not completely rewound into the cassette, cut the tongue off and leave the film in the cassette.

Hold the reel to be loaded in your left hand with the spiral wire ends at the top, pointing toward the right. Allow about 3 more inches of the paper backing to unroll. Bow the film and place it straight into the reel core. Smoothly and slowly turn the reel counterclockwise, guiding the film onto the reel. Allow the paper backing to unwind as the film is wound onto the reel.

When all but about 3 inches of the film is on the reel, you will feel the end of the film taped to the paper backing. With 35mm film in a cassette, the film stops unrolling from the cassette when the end is reached.

When you feel the tape or the end of the film is about 3 inches from the reel, carefully separate the film from the paper backing or cut the 35mm film right next to the cassette, being careful not to pull the film from the reel. Finish loading the reel.

The paper backing on 220 roll film does not run the full length of the film as does 120 film. The paper backing on 220 film serves as a leader and tailer that are taped to the ends of the film. Therefore, when using the third method described above, you must remove the paper tailer from the film before loading the reel.

Before processing film using a reel, you must practice loading it by using a roll of practice film in white light, then repeating the procedure in total darkness until you feel comfortable and do not damage the film. Only after you have the reel(s) loaded properly, should you think seriously about processing.

When a roll-film tank is used to process fewer rolls of film than the tank can hold, you must take up the extra space in the tank with enough empty reels to fill the tank. The empty reels go into the tank on top of the reels holding the film. When you are pouring solutions into the tank, completely cover ALL the reels in the tank.

When processing with a roll-film tank that has a lighttight cap, you can add or dump the chemicals without removing the cover. Only one tank is needed because the required solutions are poured out of and into the tank through the tank cover during processing. This can be done in white light. The chemicals should be arranged in the darkroom sink from left to right (developer, stop bath, etc.) and be

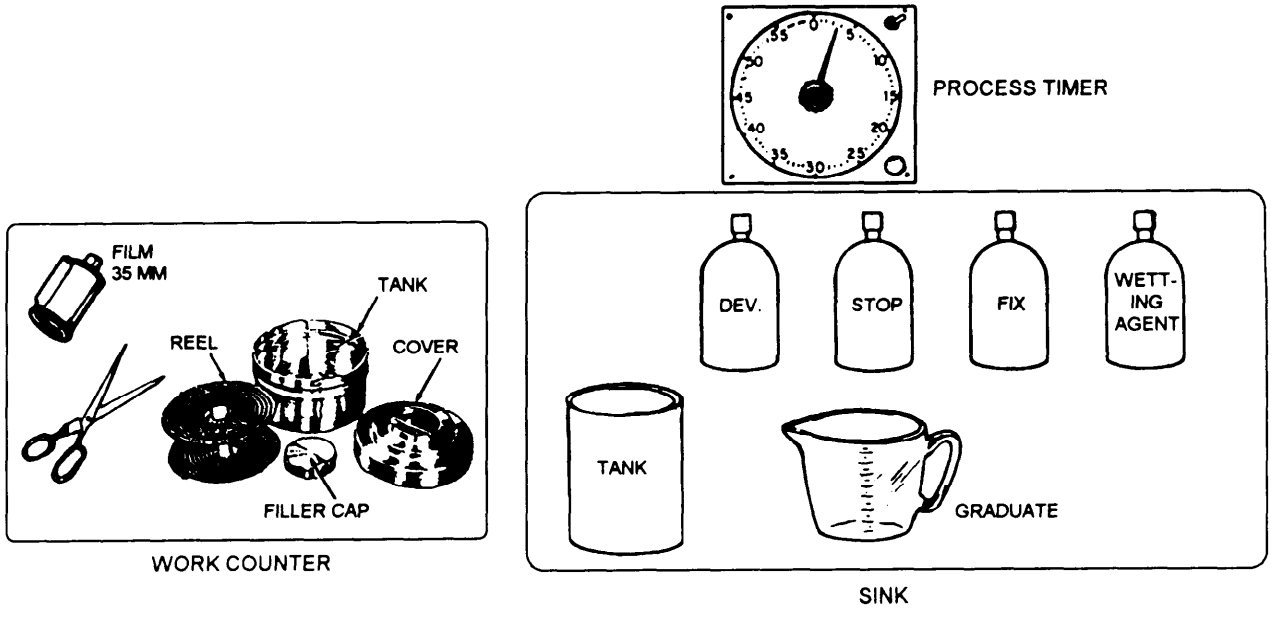


Figure 10-18.–Arrangement of materials for processing film.

brought to the correct processing temperature in a water bath (fig. 10-18).

A clean, dry area should be provided on the work counter for loading the film onto the reels. The following steps are used to process roll film in small tanks:

1. Load the reel or reels with the film to be processed.

2. Place the loaded reels into the tank. If the loaded reels do not come to the top of the tank, add empty reels to take up the space. Place the cover and cap on the tank. The lights may now be turned back on. Once the lights are on and before the film is fixed, be careful not to remove the tank cover or the film will be exposed to light and ruined.

3. Hold the tank in one hand and tilt it slightly; pour the developer directly from the graduate into the tank through the light trap pouring hole. Pour as fast as you can without spilling. As the developer nears the top of the tank, hold the tank level or set it in the sink. Fill the tank to just overflowing. This step should take about 10 to 20 seconds, depending on the tank size.

4. Once the tank is full, immediately start the timer, replace the cap, and strike the tank on the edge of the sink once or twice to dislodge any air bubbles. Now agitate the film by inverting the tank slowly end to end (fig. 10-19). The initial agitation should be 30 seconds. Place the tank in the sink on its bottom (cover up).

5. Once every minute, agitate the film for 5 seconds by slowly inverting the tank end to end. After each agitation cycle, place the tank back in the sink. If you are holding the tank during the entire developing period, the heat from your hands may heat the developer and produce unpredictable results.

6. When only 10 seconds of developing time remain, remove the *cap* from the tank cover. Immediately start pouring the developer out of the tank through the light trap pouring hole. Dump the chemicals according to local instructions of the imaging facility. This step should take about 10 seconds to complete.

7. When the developer has been emptied from the tank, fill the tank to overflowing with stop bath. The stop bath must be poured into the tank through the light trap pouring hole in the tank cover. Replace the cover cap. Agitate the film in the stop bath for about 30 seconds using the end-for-end method.

8. When the stop bath portion of the process is complete, pour the stop bath through the light trap pouring hole in the tank cover.

9. With the tank cover still in place, pour fixer into the tank and replace the cap. Dislodge the air bubbles and set the timer to the required fixing time. Start the timer and agitate the film using the same agitation as the developer.

10. When the prescribed fixing time has elapsed, remove the tank cover and pour the fixer from the tank back into the bottle from which it came. Never pour the



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Figure 10-19.–Agitation of a small tank.

fixer into the sink. The fixer can be reused and then later saved for silver recovery.

11. The film can be washed either in the tank or in a roll-film washer. When the tank is used, insert a hose down through the center of the reels until it is about 1/2 inch from the bottom of the tank. Adjust the water (at the same temperature the film was processed) so a steady overflow is created. Wash the film for about 20 minutes. When you use a rapid roll-film washer, again, adjust the water temperature and place the reels containing the processed film into the washer. Adjust the rate of water flow until the reels start to turn. When the reels start to turn, adjust the rate of water flow until the reels stop turning. Set the timer and wash the film for about 5 minutes.

12. While the film is washing, rinse the processing tank, tank cover, and cap with clean water. Fill the tank with water (check the temperature) and add the wetting agent. After the film has been washed, place the film, still on the reels, into the wetting agent solution. Replace the tank cover and cap and agitate the film in the wetting solution very S-L-O-W-L-Y for 1 minute.

13. After 1 minute in the wetting solution, remove the loaded film reels from the tank. (Do not save the wetting solution.)

14. To dry the film, attach the end of the film to a film clip in the drying cabinet. Let the film unwind from the reel as you slowly lower the reel.

When the film is unwound, depress the grip clip (if the reel has one) or remove the film from the core of the reel. Squeegee the film and attach a second film clip to the lower end of the film. Close the drying cabinet door and dry the film.

Photographer's Data Sheets

Sometimes a photographer's data sheet will accompany film that enters your imaging facility to be processed. The photographer's data sheet will provide you with information on how the film was shot, lighting conditions, and specific processing instructions. When a photographer's data sheet accompanies the film or job order, you should process the materials specified by the form.

Cleaning Up

After processing, the darkroom and all equipment must be cleaned up immediately. Rinse thoroughly all processing equipment: tanks, reels, hangers, thermometers, funnels, and so forth, in clean, warm water. Place the clean equipment where it can dry before it is needed for the next processing run. Always keep the processing room shipshape.

REVERSAL PROCESSING

Normal processing of black-and-white film produces a negative; from this negative, a positive is made. However, by using the *reversal process*, you can produce a positive image directly on the black-and-white film.

In the reversal process, a negative image is first obtained by developing the original latent image in a developer that contains a silver halide solvent. This developer dissolves some of the excess silver halides. After leaving the developer, the *negative* image is dissolved away in a bleach bath. The silver halides remaining are chemically "exposed" (fogged) and developed by a second developer that provides the positive image.

Not all black-and-white films reverse well. Films that reverse well are Kodak Direct Positive Panchromatic Film 5246 (35mm), T-max 100 Direct Positive Film, and Kodak Technical Pan Films (35mm). Instructions for reversal processing of these films can be found in the *Photo-Lab-Index.*

COLOR PROCESSING

Color adds realism to photographs. At one time color was difficult to work with. It required special cameras and specialized films that could be processed only by the manufacturer of the film. Now, color materials have been improved and are used extensively in the Navy. They are far more popular than black and white.

As discussed in chapter 2, color films have at least three emulsion layers. Primary colors affect one emulsion layer only, while complementary colors affect two emulsion layers; for example, the color cyan affects the blue and green sensitive layers. White light affects all three emulsion layers. Black has no effect on any layer. The type of process used depends on whether the film is a negative type of film or a reversal (slide) film. The most common processes used in the Navy are Kodak Flexicolor for color negatives and Kodak Process E-6 for color reversal films. The Eastman Kodak Company continually strives to improve their processes by making them more environmentally safe. Always consult the *Photo-Lab-Index* for the most current information concerning film and paper processes.

COLOR NEGATIVE PROCESSING

In negative color film, the dye couplers produced are complimentary to the primary colors of light; therefore, a blue light records as yellow, a green light records as magenta, and a red light records as cyan. All colors within a scene are recorded through varying combinations of these yellow, magenta, and cyan dyes. The color negative is a halfway stage to a color print.

The cyan and magenta dye image layers formed by color processing absorb some light wavelengths that should be transmitted. In negative color film, these absorbed wavelengths of light cause a color cast when printed. To prevent this color shift, the manufacturer has given the green and red sensitive emulsion layers a yellowish and pinkish tint, respectively, during manufacturing. These tints are what form the overall orange mask that you see in finished color negatives. Some color film used for aerial photography does not have this orange mask. This allows for a direct interpretation of the negative image. An orange-masking filter is added when these films are printed.

The Kodak Flexicolor process is used for processing color negative films and some monochrome film, such as Ilford XP2. There are four chemical steps and two wash cycles in the Flexicolor process. They are as follows: color developer, bleach, wash, fix, wash, and stabilizer.

Color Developer

The first step in color negative processing is color development. A color developer in color processes works nearly the same as a black-and-white developer. The exposed silver is developed by a developing agent and converted to metallic silver and by-products are released. As the color developer is working at developing the silver, it becomes oxidized and reacts with nearby dye couplers. Dye couplers are built into the emulsion around all of the metallic silver sites. The primary function of a color developer is to develop the exposed silver halide crystals to metallic silver and then form dye around the metallic silver, using the oxidized color developing agent.

Temperature of the color developer is the most critical of all the processing steps. The temperature of the color developer must be 100°F ±0.25°F (37.8°C ±0.15°C). All other wet steps in the process can be within the range of 75°F to 105°F (24°C to 41°C); however, it is best to maintain all solutions at constant temperatures.

Bleach

Bleach is found in all color processes. The purpose of the bleach is to take the metallic silver still in the color film (or paper) and convert it to a form that can be fixed. In color products, all of the silver must be removed. Only the color dyes form the image. The bleach chemically converts the silver metal back to a soluble silver halide.

Fixer

The function of fixer is the same in color processes as it is in black-and-white processes. A fixer converts the silver halide to a water soluble form. Most fixers use thiosulfate as the fixing agent in an acidic solution. When fixing is incomplete, unwanted silver remains in the image. This causes a loss in contrast, added density, and an unwanted color cast.

Stabilizer

The final wet step in color negative film processing is the stabilizer. The main purpose of this solution is to provide a wetting agent to prevent spotting of the film and to prevent unused magenta dye couplers from attacking the newly formed magenta dye.

Unlike black-and-white film processing, color negative film cannot be “push processed” successfully; therefore, you must choose a film with an appropriate film speed for the lighting conditions in which you photograph your subject.

COLOR REVERSAL FILM PROCESSING

Color transparency film forms dyes according to a reversed silver positive; for example, a yellow dye image forms in the top emulsion that corresponds to an absence of blue in the original scene. This yellow dye subtracts blue light. A blue image is formed by magenta dye (minus green) and cyan dye (minus red), thus leaving blue. In color transparency film, the dyes subtractively produce a correct color positive image of the scene photographed.

The Kodak E-6 Process is used in the Navy for processing color reversal film. There are seven chemical steps and two wash cycles in the Kodak E-6 Process. They are as follows: first developer, wash, reversal bath, color developer, prebleach, bleach, fixer, wash, and final rinse.

The first chemical step is the first developer. The first developer is a black-and-white developer that converts the exposed latent image in each emulsion layer to a metallic silver. Like black-and-white negative processing, after the film leaves the first developer, there are undeveloped areas where the silver halides are unaffected by camera exposure. It is these undeveloped areas that the final color positive images are formed in reversal film.

After the first developer, the film is chemically fogged or “re-exposed” in the reversal bath. The reversal bath exposes the silver halides that were not developed in the first developer. This re-exposure is what forms the positive image. After 1 minute in the reversal bath, the normal room lights can be turned on.

After fogging, the film is developed in a color developer. The color developer works the same way in color reversal processing as it does in color negative processing. It changes the fogged silver halides to black metallic silver and at the same time, cyan, magenta, and yellow dye couplers are formed by the exhausted developer.

At this stage the film looks completely black because the formed dyes are shielded by the developed silver. The film is then placed in a prebleach. The prebleach prepares the film for the bleach and also stabilizes the dye layers.

The metallic silver is removed by the bleach and fixer processes. The bleach and fixer work the same way as they do for color negative processing. After the silver is removed, only the dyes remain, forming the image.

The film is then washed to rinse away any remaining chemistry and soluble silver. The last chemical step in the E-6 process is the final rinse. Final rinse provides a wetting agent to aid in uniform drying.

It is possible to “push process” (underexpose and overdevelop) or “pull process” (overexpose and underdevelop) most color reversal film; however, some sacrifice in quality results in "push processing." Less detail in the shadow areas (weaker blacks), less exposure latitude, and noticeably increased grain occur when color reversal film is "push processed." When the film speed is altered, only the first developer time is changed. All other chemical steps remain the same. You should not exceed two f/stops when you intend on “push” or “pull” processing.

MACHINE PROCESSING

Today most film processing is performed by machine, especially in larger imaging facilities. Machine processing has many advantages compared to hand processing. Machines can process high-volume production more efficiently and more consistently compared to hand processing. When machines are used, the variables involved in processing can be controlled more easily. Time, temperature, and agitation can be kept constant if the machine is properly maintained and operated properly. With fully automatic processing machines, all you must do is feed the film or paper into the machine and retrieve the finished product.

When there are advantages, there are also disadvantages to machine processing. Machines require maintenance, can jam, occupy precious shipboard space, and may require special plumbing, ventilation, or power requirements. The need for proper maintenance is most critical. Poor equipment maintenance is probably the major cause of machine processing problems. Therefore, it is very important for scheduled preventive maintenance to be performed properly on all imaging equipment, especially automatic processors. The best images captured by a camera are not of any use if they are not processed correctly and without defects. You must be qualified completely in the Planned Maintenance System (PMS) to become a valuable member of an imaging facility.

In a high-volume production facility, the advantages of automation far outweigh the disadvantages. There are



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Figure 10-20.–Image Maker processcr.

numerous automatic processors available on the market today. Two types of machine processors are commonly used in Navy imaging facilities. They are the rotary drum and the roller transport type of processors.

ROTARY DRUM PROCESSOR

The semiautomatic processor most commonly used in Navy imaging facilities is the Image Maker, manufactured by the King Concept Corporation (fig. 10-20). When this type of processor is used, film and paper are processed in a lighttight canister. Before being processed, the material must first be loaded on stainless steel reels for roll film or in a plastic basket for sheet film or paper. Depending on the setup of the processor, the holding tanks are either filled with chemicals manually, or they may be filled automatically. The solutions are then automatically added to and dumped from the processing drum. The time, temperature, and solution steps are all controlled by a computer. After the material is processed, it is then removed from the drum, squeegeed, and dried.

The advantages of a rotary drum processor is it is of relatively low cost, small in size, and can run many different processes through the same machine. The major disadvantage is that the chemicals are dumped instead of replenished which is not environmentally sound and can be costly.

ROLLER TRANSPORT PROCESSOR

Automatic processors commonly use roller transport systems (fig. 10-21). When you are using these machines, the material being processed moves at a constant speed by friction. The materials are guided through the processing solutions by a series of rollers and rack assemblies. On many processors, a leader tab must be attached to the beginning of the roll to aid in pulling the film through the machine.

The size of the solution tanks and the length of the path through the solution determine how long the material must remain in each solution (processing time). On some automatic processors, the finished, dried, processed material leaves the processor and is then automatically cut and sorted.

Roller transport processors contain two major sections: the wet section and the dryer section. The wet section contains the developer, fixer, and wash tanks. The film is then transported through a squeegee assembly and enters the dryer.

Many different types of processors are used throughout the Navy. Each type has specific installation,

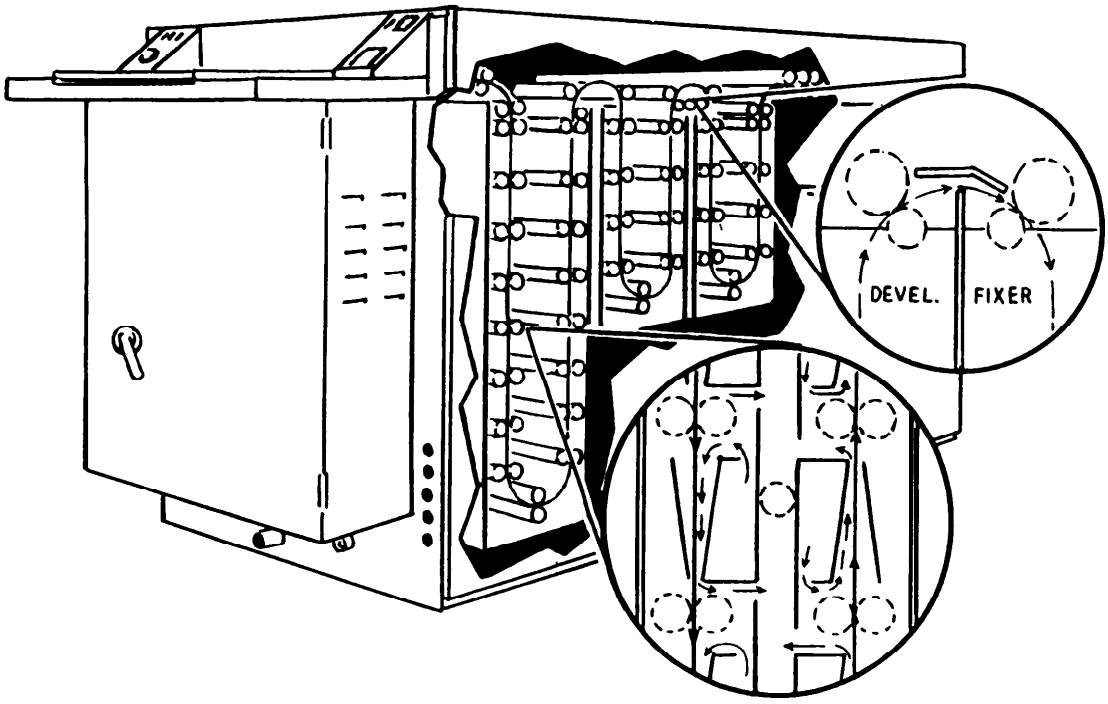


Figure 10-21.–Roller transport processor.

operation, and maintenance instructions supplied with it. Therefore, in this section only general information that applies basically to any machine processor is discussed.

TRANSPORT SPEED

Most black-and-white automatic film processors have a variable speed operation. Unlike hand processing where developing time is measured in minutes and seconds, machine processing developing times are measured in feet-per-minute (fpm). Both methods measure the length of time the material is affected by the developer and other solutions. Most color processors have a set machine speed that can only be adjusted slightly because color materials must be processed to specific parameters so processing cannot be manipulated.

The time the solutions are allowed to act on the film or paper is a result of the speed that the machine moves the sensitized material and the length of time the material is immersed in a particular tank. Most machines have an fpm indicator that shows the set speed of the processor. The temperatures of solutions and the specific number of feet in each section of the machine are usually constant factors. It is the rate the paper or film travels that determines the total processing time; for example, if the speed is set to 10 fpm and the total roller path in the developing tank is 30 feet, a certain point on the material being developed takes 3 minutes (30 ÷ 10).

Regardless of the machine speed, film or paper cannot be processed faster than the total required solution times. For example, you are processing film that requires a processing and drying time of 10 minutes and 20 seconds. When the machine is processing this film, it takes 10 minutes and 20 seconds before the first foot of film leaves the dryer. However, the total time to process the entire roll is related to the speed of the machine and the total length of the material. For example, if the machine speed is 10 fpm and the roll is 10 feet long, the film takes 10 minutes, 20 seconds, plus 1 minute (10 ÷ 10). With a 200-foot roll, access time is 10 minutes, plus 20 seconds, plus 20 minutes (200 ÷ 10), or a total of 30 minutes, 20 seconds. It is important for you to know the access time of the processor. When the material being processed does not exit the machine in the required time, a machine malfunction or jam is evident.

WATER TEMPERATURE AND FLOW RATE

Wash water is an important processing consideration. Not only is the water temperature important but also the flow rate of the water. Two factors that must be considered are as follows: sufficient flow to ensure

complete washing of the material and to control or eliminate waste.

If the wash-water temperature is allowed to drop to 65°F (18°C) or below, emulsion staining may result. As the temperature decreases, less emulsion swelling occurs, reducing the effective penetration of fresh water supplied to the emulsion. When the emulsion does not swell, the chemical-laden water does not get out through the emulsion surface. These retained chemicals can cause stains.

The wash water flow rate is another important factor to consider. This rate must be high enough to wash the material, but no more. When insufficient water flow is supplied to the machine, crystallized chemicals may be seen on the material, and additional staining can result. You must not adjust the water flow rate higher than is needed. A few extra gallons-per-minute flow rate may not seem important; however, over time this effect can be extremely costly, particularly aboard ship.

SOLUTION TEMPERATURE

In machine processing, the temperature may vary, depending on the machine and the kind of processing being performed. High-speed processing machines operate at higher solution temperatures. Temperature control is critical and must be maintained to produce correct results. Although this may be considered a variable factor, the temperature is controlled automatically by processing machines. In some machines, the solution tanks are immersed in a temperature-controlled water jacket. By controlling the water temperature within the water jacket, you can control the temperature of the solutions inside the tanks. In other machines, the solution temperature is directly controlled by separate heaters or heat exchange control units in the recirculation system. A temperature probe in the solution tank monitors and controls the temperature control unit.

SOLUTION LEVELS

The solution levels of a processor must be checked before processing material. If the solution level is too low, stains, improper tracking, and roller marks may affect the film or paper. When the machines are shut down for a period of time, some evaporation occurs. Since only the water from the solution evaporates, you must top off the solution tanks with water before processing material. There is a certain amount of carry-over of solution from one tank to another within the machine. Usually, chemical carry-over is minimized with roller squeegees. When the replenishment rate of the processor is set properly, this carry-over is compensated by supplying fresh chemistry to the solution tanks.

REPLENISHMENT

Most processing machines use relatively large quantities of solutions to carry out the process properly. However, even considering the large quantities involved, certain chemical components within a given solution are used up at varying rates. In addition, there are certain reactions that form by-products that build up in the tank of the processor; for example, bromide (a restrainer) gradually builds up in the developing solution. Also, there is a certain amount of carry-over of solutions from one tank to another. This causes a continuous change in solution strength and solution purity. The replenisher solution replaces the used chemicals, dilutes the excess chemicals or by-products that have built up, and replaces the solution lost by carry-over and evaporation.

The replenishment system used in machine processing is called the *bleed* method. When the bleed system is used, a calculated amount of replenisher solution is added and forces some of the used solution out through an overflow drain in the solution tank. You must check the established replenishment rates as well as the replenisher holding tanks before and during processing. Inconsistent results occur when the process is not replenished correctly.

DRYER TEMPERATURE

After the material is processed and washed, it continues through the machine into the drying cabinet where moisture is removed. The drying cabinet is more than a heated compartment for the processed material. In a majority of machines, both the temperature and the humidity of the cabinet are carefully controlled. Too little drying causes the emulsion to be tacky, whereas too much drying may produce excessive curl and brittleness. Brittleness, once it occurs, cannot be eliminated; so it must be prevented. Both the temperature and the relative humidity must be adjusted for the speed of the machine and the type of material being dried.

Under ideal conditions, the drying cycle should yield a stable 50 percent relative air humidity. To lower the relative humidity of air, you must heat the air; this accelerates the evaporation of moisture. The rate of evaporation and the relative humidity are directly

proportional to the temperature. When the temperature is too low, evaporation is slowed down. When it is too high, the emulsion may be damaged.

Roller transport processors provide very consistent processing results and can be converted easily to a new process. The disadvantages of roller transport processors are: they can leave scratches and scuffs from dirty rollers touching the film, they require a high amount of maintenance due to the large number of moving parts, and oxidation can be a problem due to the churning action of the rollers in the chemistry.

QUALITY PROCESSING

The processing required to produce a quality product of any particular film varies with different developer and film combinations, time and temperature of the process, agitation, the film exposure, and the skill of the darkroom worker. A good, high-quality image is one that is free from all processing faults, including scratches and dirt, and so forth.

When processing black-and-white film, your goal is to produce a "normal" negative that is as fault-free as possible. Normal is a rather vague term; however, a normal negative is one that yields a pleasing print or reproduction of the original scene when printed without a printing filter or with a No. 2 printing filter.

When film is exposed and processed properly, it is a normal negative. However, when a negative varies from normal, you should be able to determine what conditions caused the deviation.

A negative has several *basic* characteristics to consider when evaluating quality. These basic characteristics are as follows:

- General negative density or opacity to light.
- Image highlights or areas of greatest density.
- The shadows or areas of least density.
- Contrast or the differences between highlight and shadow densities.
- Tonal gradation or the range of grays between the highlights and the shadows.
- Graininess or the appearance of silver grains in a negative that have clumped together. The size of the clumps determines the degree of graininess in the processed material.

All the basic characteristics of a negative are affected to some extent by a combination of exposure and development. By studying these characteristics, you can usually determine the cause of an error or poor quality in a negative.

DENSITY

Density determines how much of the incident light falling upon a negative passes through the image. When a small amount of silver is present in the negative, the image appears thin (transparent), and it has low density. When there is a large amount of silver present, only a small amount of light passes through the image, and the negative is said to have high density.

A low density, thin negative can be caused by underexposure or underdevelopment or by a combination of the two. A heavy or dense negative is the result of either overexposure or overdevelopment or a combination of the two.

HIGHLIGHTS

The highlights, or dark areas, of a negative for most purposes should not lack detail. When detail is lacking because the highlights are too dark, the highlights are too dense or blocked up. Excessive highlight density is caused by overexposure and/or overdevelopment. When both the highlights and the shadow areas are too thin and lack detail, the negative is probably underexposed. Thin highlights are caused by underexposure and/or underdevelopment.

This may seem like a repetition of the previous discussion on density. However, a negative could and may have *overall* good density except in the highlight areas. This situation is a result of exposure latitude that is not great enough for the scene brightness range.

SHADOWS

The shadows, or the more clear areas of the negative, also should contain image detail. If these areas are so thin and weak that they are transparent or nearly so, the shadow areas are said to be lacking in detail. Loss of shadow detail is caused normally by underexposure.

The need for detail in both the highlights and the shadows for photographs of most subjects cannot be stressed too strongly. One is as important as the other in the production of good photographs.

CONTRAST

Contrast is the difference in density between the highlights and the shadows in a negative. When this

difference is great, the negative is said to be contrasty. When the density difference is small, the negative is said to be flat or lacking in contrast.

For a negative to have normal contrast, the density differences between the highlight and shadow areas of the negative must be proportional to the reflective brightness range of the subject photographed

A contrasty negative usually is the result of overdevelopment but also may be caused by a high scene lighting ratio (a contrasty original scene). A flat negative, on the other hand, may be caused, primarily, by underdevelopment or a low-contrast original scene.

TONAL GRADATION

Photographers often concentrate on the density and detail of highlights and shadows when they should actually be considering the most important or middle tones of the negative. Middle tones are the various tones of gray between the highlights and the shadows; that is, the densities that are not highlights or shadows are termed middle tones or intermediate tones. The middle tones vary with the type of film and the subject contrast. A negative should have a range of middle tone densities that correspond proportionally to the middle reflective brightness of the subject. A panchromatic negative that does not have proportionate midtones is contrasty or flat.

GRAININESS

Because photographic images made from film are made up of fine silver grains, the images may appear "grainy" or exhibit graininess (fig. 10-22).

All negatives show graininess to some extent. The most important factors affecting negative graininess are as follows:

- The composition of the emulsion or the inherent graininess of the emulsion. That is to say, the size of the grains used to produce the emulsion.

- The type of developer used. When fine grain is desired, a fine-grain developer with the appropriate film should be used.

- The extent of development. Overdevelopment is a major cause of excessive graininess.

- Exposure or negative density. Overexposure is another key contributor to graininess. As negative density increases, so does graininess.



Figure 10-22.–Grain structures in emulsions.

- Image sharpness. The sharper the film image, the greater the image detail and the less apparent the graininess.

EFFECTS OF EXPOSURE AND DEVELOPMENT VARIATIONS

The nine negatives reproduced in figure 10-23 compare the effects of exposure and development variations. From the left, they show the effects of development; from the top, they show the effects of exposure. The center negative has been given both correct exposure and normal development and is a "normal" negative that will print without a filter or with a No. 2 filter.

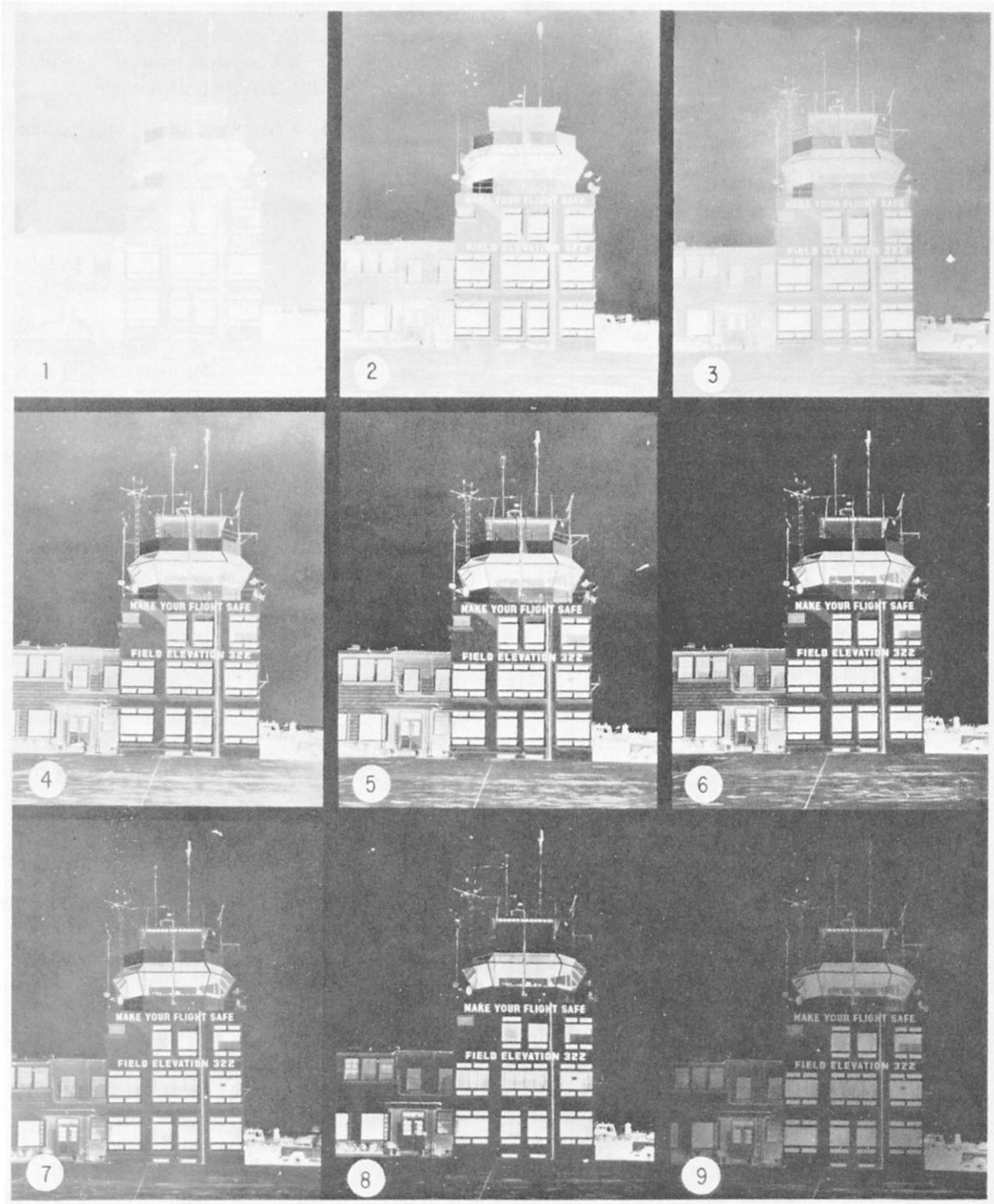
Negatives 1, 4, and 7 have been underdeveloped, while 3, 6 and 9 have been overdeveloped.

The negatives across the top-1, 2, and 3-are underexposed and lack detail in the shadow areas. Increasing development (No. 3) had no appreciable effect on the lack of shadow detail. Little can be done to improve negative quality when exposure is insufficient. Underexposure is identified by lack of shadow detail.

The negatives across the center-4, 5, and 6-were given correct exposure and all have sufficient shadow detail. However, No. 4 was underdeveloped and is flat or lacks adequate contrast. Negative No. 5 received normal development, has good shadow detail, and good contrast. It is a "normal" negative. Negative No. 6, although having received correct exposure, was overdeveloped. This resulted in excessive highlight density with a loss of highlight detail and excessive contrast. The highlights in both 6 and 9 are too dense.

Negatives 3, 6, and 9 are all overdeveloped. The correctly exposed negative, No. 6, is so dense that almost no detail is visible in the highlights. The highlights of the overexposed and overdeveloped negative, No. 9, are completely blocked up.

When a correctly exposed film is given normal development as in negative No. 5, the negative has



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Figure 10-23.–Exposure and processing affects.

clearly defined detail in all parts of the image from the strongest highlights to the weakest shadows. The contrast is satisfactory. It may not reproduce the contrast of the original scene exactly, but it has sufficient contrast to produce a pleasing reproduction.

When the film is overexposed and normally developed, as in No. 8, the highlights in the image show a loss of detail. Giving the overexposed film less than normal development may save some highlight detail, but it also reduces the contrast. When the overexposed film is overdeveloped, as No. 9 was, all highlight detail is destroyed and the contrast is also reduced.

Table 10-1 is a listing of defects that commonly occur in film processing. The appearance, the cause, and the remedy for each of the defects listed are also provided.

Table 10-1.–Negative Defects: Their Appearance, Cause, and Remedy

Defect	Appearance	Cause	Remedy
Abrasion marks or streaks.	Fine black lines, usually resembling pencil scratches and running in the same direction.	Friction on emulsion caused by improper handling or storage. Dirt, or grime, in camera or magazine.	Great care should be taken in storage of film. Boxes containing film should be stored on end, so no pressure is exerted on the surface of the emulsion. Care, also, should be taken not to rub or drag sensitized material over a rough surface. Be sure camera back or magazine is clean and free from dirt, or grime.
Air bubbles.	An air bubble occurring during development shows as a small, transparent spot. Sometimes minute dark streaks lead from the spot. When the negative is rocked in a tray, streaks project from each side of the spot in the direction the tray was rocked. If the tray is rocked in two directions, streaks form a cross with a transparent spot in the center. In tank development. dark streaks usually form at the lower edge of the transparent spot. In the fixing bath they show as small, round, dark spots.	Transparent spots occurring in the developer are caused by bubbles of air on the surface of the emulsion. These prevent the developer from coming into contact with the emulsion. Darkened streaks are the result of excess oxidation of the developer, caused by air in a bubble. Dark spots that occur in the fixing bath are caused by a pocket of air holding the fixer away from the emulsion and allowing a slight continuation of development.	Immerse film carefully and thoroughly in developing and fixing solutions. Move film during development and fixation to break up and prevent air bells. Water always contains some air and when there is a rise in temperature, air is expelled and gathers in the form of small bubbles on the inside of the tank and also on the surface of the film during preliminary stages of development.

Table 10-1.–Negative Defects: Their Appearance, Cause, and Remedy-Continued

Defect	Appearance	Cause	Remedy
Blisters.	They resemble the familiar ones that are caused by slight bums on human skin.	Liquid or gas formed between the emulsion and film support when the solution has become too warm and has loosened the gelatin from its support. Also, produced by developer and fixer being too strongly concentrated. Changing film from one bath to the next may cause the formation of gas between the emulsion and support. Frequently caused by taking the film from an alkali solution and placing it into a strong acid. Another common cause is allowing water from a faucet to flow directly on the emulsion.	Blisters can be avoided by eliminating their causes.
Brown spots.	Small brown- or sepia-colored areas or spots on the negative.	Produced by oxidized developer or by fine particles of chemicals settling on the film before development. May also occur during washing, from rust, and other impurities in the water.	Avoid exhausted or oxidized developer. Keep processing room clean and free from dry chemicals. Filter the wash water.
Crystalline surface.	Surface of the negative emulsion has a crystalline appearance, resembling frost on a windowpane.	Insufficient washing after fixing. Hypo remains in the film and crystallizes.	Increase the final wash time.
Dark lines.	These lines are divided into two distinct classes. The first class, those that run from dark areas to more transparent areas of the negative, and the second class, those that run from the more transparent areas to the darker areas. In both cases, lines are wider, not as clean cut, and not nearly as parallel as abrasion marks.	The first class is caused by insufficient agitation of the negative in tank development. Cause of the second class is thought to be of an electrolytic origin.	For the first class, more frequent agitation during development. The remedy for this class aggravates the defect in the second class. Only known remedy is to remove all film hangers from the tank four or five times during the developing period, holding the hangers in a bunch, and allowing the corners of the hangers to rest on the edge of the developing tank for 10 to 15 seconds.

Table 10-1.–Negative Defects Their Appearance, Cause, and Remedy-Contiuued

Defect	Appearance	Cause	Remedy
Fading tendency.	Sepia- or yellow-colored stains or areas in the negative.	Incomplete fixation or insufficient washing causes fading. Remnants of the fixing bath left in the emulsion continues its action, and in time, this defect appears.	Properly fix and wash negatives.
Fingermarks.	Imprint of fingers shows up on negative.	Impressing wet or greasy fingers on the emulsion of film before or during development and fixation. If mark is merely an outline of the finger, it was caused by water or grease on the finger; if dark, it was caused by developer; if transparent or light, it was caused by fixer.	Keep hands clean and dry when handling film. Sometimes natural oil on the fingertips causes grease marks. When fingers become wet with water or solutions, wash and dry thoroughly before attempting to handle film.
Fog (Aerial).	A slight veiling of the negative or parts of the negative.	Negative exposed to air during development. Occurs most frequently in freshly mixed developers.	
Fog (Dichroic).	Usually a fog of little density, consisting of finely divided particles of silver. When viewed by transmitted light, it is pinkish; when viewed by reflected light, it appears reddish green.	Hypo or excessive amount of sulfite in the developer.	Removed by treating the negative in a weak solution of potassium permanganate. Further prevention through use of clean tanks for developer and fixer.
Frilling.	Edges of the gelatin become detached from the base. Detached edge of emulsion may either break off or fold over.	Careless handling; using solutions that are too warm; insufficient hardening of emulsion due to insufficient fixation; exhausted fixing bath or one containing insufficient amount of hardener; or excessive washing. Frilling is usually caused by a combination of careless handling and any other mistake that will render the emulsion or film soft.	Handle film carefully and sparingly; use working solutions that are mixed correctly and are at the proper temperature. Wash film sufficiently, but never excessively.

Table 10-1.–Negative Defects Their Appearance, Cause, and Remedy–Continued

Defect	Appearance	Cause	Remedy
Air bubbles.	Minute pimples or blisters.	Develop by transferring the negative from strongly concentrated developer to strongly acid fixing bath without thoroughly rinsing after removing it from the developer and before immersing it in the fixing bath. In warm weather, air bubbles may appear even when using solution of normal strength, if rinsing between development and fixation has been insufficient.	Use an acid stop bath.
Pitmarks.	Fine holes or pits in emulsion.	Excessive alum in fixing bath; sulfurous precipitation from fixing bath when negatives are fixed in a tray; and film being dried too rapidly.	Proper fixing and drying.
Pinholes.	Minute transparent spots.	Dust on film before exposure.	Proper handling of film. Clean camera back or film holders before use.
Reticulation.	Leatherlike graininess or wrinkling of the emulsion.	Too great of a difference in the temperature of baths or between final wash water and the air in which the negative is dried. Gelatin may become badly swollen due to the temperature of a solution or wash water, and upon shrinking, contracts irregularly due to the metallic silver incorporated in the emulsion. Excessive softening of the emulsion followed by a strong hardening bath, or an alkaline treatment followed by strong acid.	Keep all solutions at the same temperature. Reticulation effect may sometimes be removed by placing the negative in a10-percent solution of formaldehyde for a few minutes and then drying it rapidly with heat. Use ample ventilation when drying negatives treated in formaldehyde.

Table 10-1.-Negative Defects: Their Appearance, Cause, and Remedy-Continued

Defect	Appearance	Cause	Remedy
Streaks.	Streaks and patches. In the case of spots, may be dark, white, or transparent.	May be due to uneven development, caused by insufficient agitation. May also be due to developer splashed on the film before development, a dirty tank, fixer tray or tank used for developing, or a light fog. If the edges of the film are clear, trouble is in the camera; if the edges are fogged, it is due to a light leak in the film magazine or processing tank. Certain types of resinous woods and varnishes cause dark patches. White or transparent patches may be due to obstructions in the camera that prevented light from acting on the film; an oil or grease that prevented action of the developer; hypo on film before development. Drying marks in the form of teardrops or white patches are caused by splashes of water on a dry negative or by leaving spots of water on the film before drying, especially if the film is dried in warm air.	Trace the cause of the streaks. In many cases, they can be avoided in the operation and maintenance of equipment. When drying negatives, be sure to use wetting agent or stabilizer.

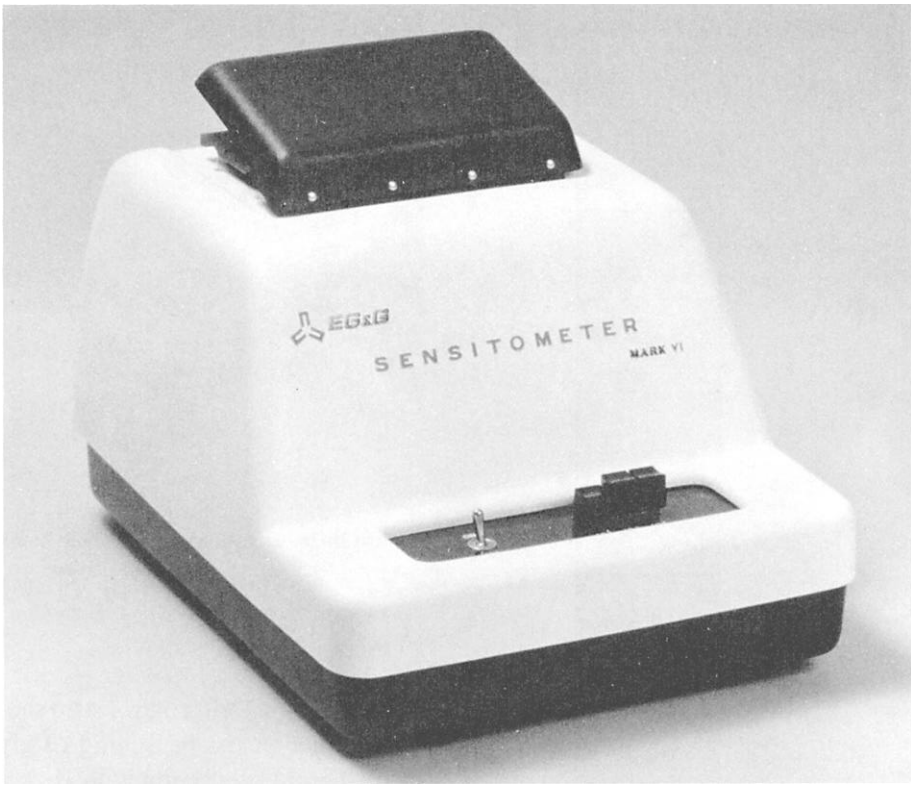
PROCESS MONITORING

To consistently produce the highest quality photographic products possible and to prevent chemical processing defects, you must monitor the photographic processes. From a hand-processing system to a sophisticated, computerized processing system, process monitoring is necessary to achieve high quality on a consistent basis. When it is performed routinely, process monitoring can detect minor problems before a major casualty to your imagery results as well as aid in the proper replenishment of your processing system.

The area of quality control and process monitoring can be very complex. Some Navy Photographer's Mates earn an NEC and specialize in the field of quality control for photographic processes. It is not the intention of this training manual to provide you with the information necessary to become a specialist in photographic quality control; however, you must learn the appropriate steps to monitor the process.

The production of high-quality photographic products requires control over all the factors that affect light-sensitive materials. Film exposure and processing are the most important of these factors. Negatives or positives that have not been uniformly and correctly exposed and processed may provide unusable results. By monitoring the process and providing high-quality products, you can save time and operating costs by reducing waste and retakes.

Any monitoring system for the photographic process requires a reference or standard, and comparison of daily production to this standard. Visual comparison of the reference to the standard is very subjective and limited in accuracy because of personal opinion. A more accurate method is to measure your production against the standard. Two means of making



Courtesy of EG&G, Inc.
302.288X

Figure 10-24.–EG&G sensitometer.

these measurements are through sensitometry and densitometry. When sensitometry and densitometry are used, variations from the standard and the corrections recommended are expressed in numbers, not in terms of personal opinion.

SENSITOMETRY

Sensitometry is the science of determining the photographic characteristics of light-sensitive materials. In sensitometry, special test or control strips are prepared by accurately exposing the material with varying amounts of light. These test strips are then processed.

A *sensitometer* is an instrument used to produce the special test strips called sensitometric strips. A sensitometer is used to produce these sensitometric strips because it provides consistent and repeatable exposures of a known quantity and quality of light. The sensitometer is used to expose a strip of film with varying amounts of known exposure on the same strip of film. Since the sensitometer provides repeatable exposures each time, any changes in density indicates a change in processing. In Navy photography, the sensitometer is used to expose black-and-white materials only. There are several uses for sensitometric strips; but in this training manual, we are only concerned with monitoring a process. Here the sensitometric strips are used as control strips. Control strips are made and processed under the controlled conditions of time, temperature, and agitation. This is true for both black-and-white and color materials. Black-and-white control strips are usually made in the photo lab, while color control strips are obtained by the manufacturer of each material.

Ideally, a sensitometer should be designed so you can accomplish the following objectives:

1. Predetermine the total amount of exposure.
2. Determine the difference in exposures given to various areas.
3. Control the color quality of the light.
4. Consistently reproduce or duplicate the same lighting conditions.
5. Provide a wide range of exposures.

The sensitometer used most commonly in the Navy today is the Egerton, Germeshausen, and Grier (EG&G) sensitometer (fig. 10-24). This sensitometer uses a

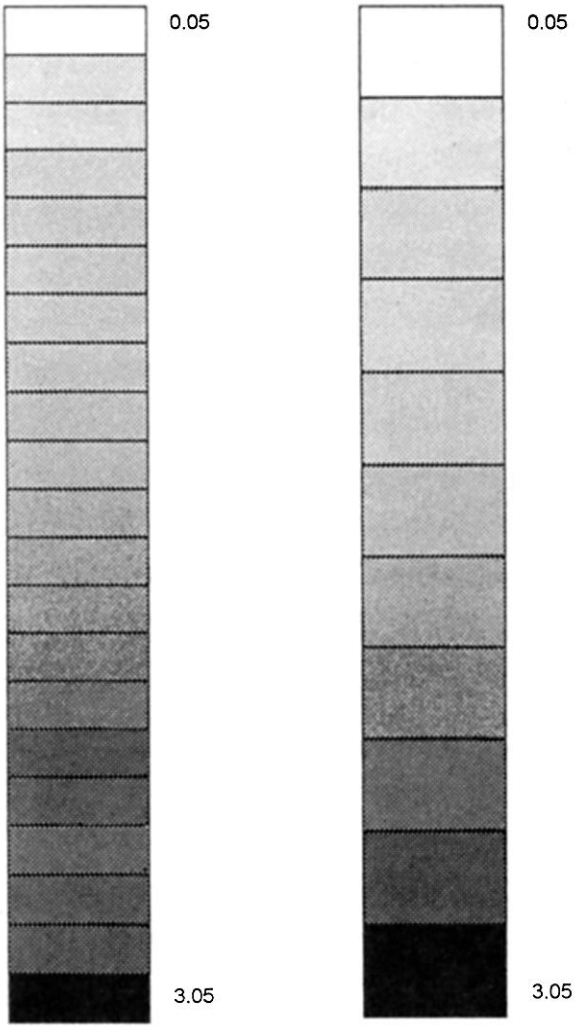


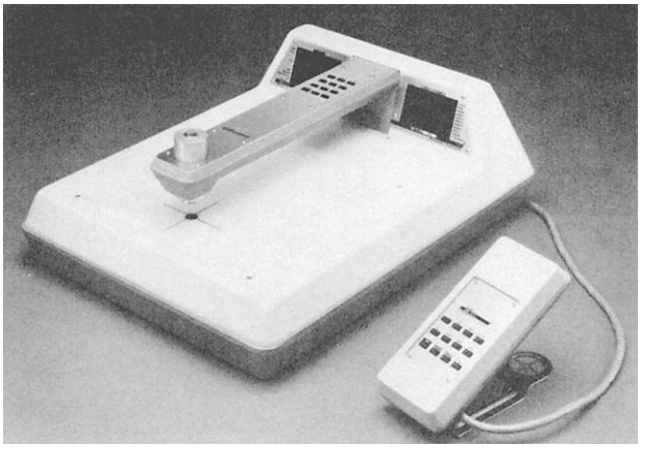
Figure 10-25.–Step tablets.

daylight balanced xenon flashtube. It can also produce exposure times from 1/100 to 1/10,000 second.

Step Tablets

A sensitometer is set up to make only one exposure. In order to provide a range of exposures, a step tablet is placed between the light source and the light-sensitive material. The step tablet is a strip of neutral-density filters in equal increments, ranging from 0.05 to 3.05. This range provides a 10 f/stop range. The most common step tablets are as follows (fig. 10-25):

1. 21-step tablet-1/2 f/stop between each increment.
2. 11-step tablet-1 full f/stop between each increment.



Courtesy of X-Rite, Inc.
302.339X
Figure 10-26.–Densitometer with both transmission and reflection capabilities.

Control Strips

A sensitometric control strip should be processed as a minimum-at the beginning of a production day (or shift), before any production is processed, and before shutdown. You should process a control strip just before an important mission, or a special-interest film is processed.

To expose and process a control strip, you should take the following steps:

1. Take the film (in a lighttight container) and place it next to the sensitometer.
2. Turn on the sensitometer and allow it to warm up for a minimum of 15 seconds.
3. Turn off the room lights.
4. Place the film emulsion-side down on the sensitometer and lower the platen to make your exposure.
5. When hand processing or using a rotary tube type of processor, load the control strip on the reel. When machine processing, replace the film in a lighttight container. Turn on the room lights and turn off the sensitometer.
6. When a roller transport processor is used, check the speed, temperatures, and the proper operation of all systems.
7. Stick the film into the processor so the lightly exposed end of the film enters the machine first. When hand processing or using a rotary tube type of processor, process normally.



302.290

Figure 10-27.–Control strips read from center of each step with emulsion facing up.

DENSITOMETRY

A densitometer is an instrument used for measuring and reading the density of film and paper directly. Film is read on a transmission densitometer, and paper is read on a reflection densitometer. Most densitometers supplied by the Navy today have both transmission and reflection reading capabilities on the same meter (fig. 10-26).

A densitometer uses a photoelectric cell to measure the light transmitted through film or reflected from paper electronically. Before a densitometer can be used, it must be checked and calibrated against a reference standard. To use the meter, you must place the material to be measured, emulsion-side up, in the light beam between the source and the photocell. The density reading is then read directly from the meter.

There are several sets of filters incorporated in the head of the densitometer. When you are reading black-and-white materials, the yellow filter must be in place. When color materials are read, there are two different sets of filters that are used. They are Status A and Status M filters. Status A filters are used to read color transparencies and prints. Status M is used to read color negative film that has an orange mask

Only certain steps of the control strip are read. The steps that you are required to read are established by the manufacturer of the material or are established by the quality control technician within your imaging facility. When you are reading the steps on your control strip, be sure that the emulsion side is facing up and take the reading from the center area of each step (fig. 10-27).

PROCESS CONTROL CHARTS

A process control chart provides a visual representation of a process. Control strips that are processed and read on a densitometer are then plotted on a control chart. The points plotted on the graph indicate what has occurred in the process at the time the control strip was processed. Through the use of control charts, a determination can be make whether the process is operating normally. As stated before, only selected steps of a control strip are monitored. For black-and-white film, the minimum steps monitored are as follows: base plus fog (B + F) or gross fog, high density, low density, speed point, and contrast.

For each step monitored on a control chart, there are three lines. The center line represents the mean (X) (pronounced “bar X”), or average, a top line that represents the upper control limit (UCL), and a bottom line that represents the lower control limit (LCL).

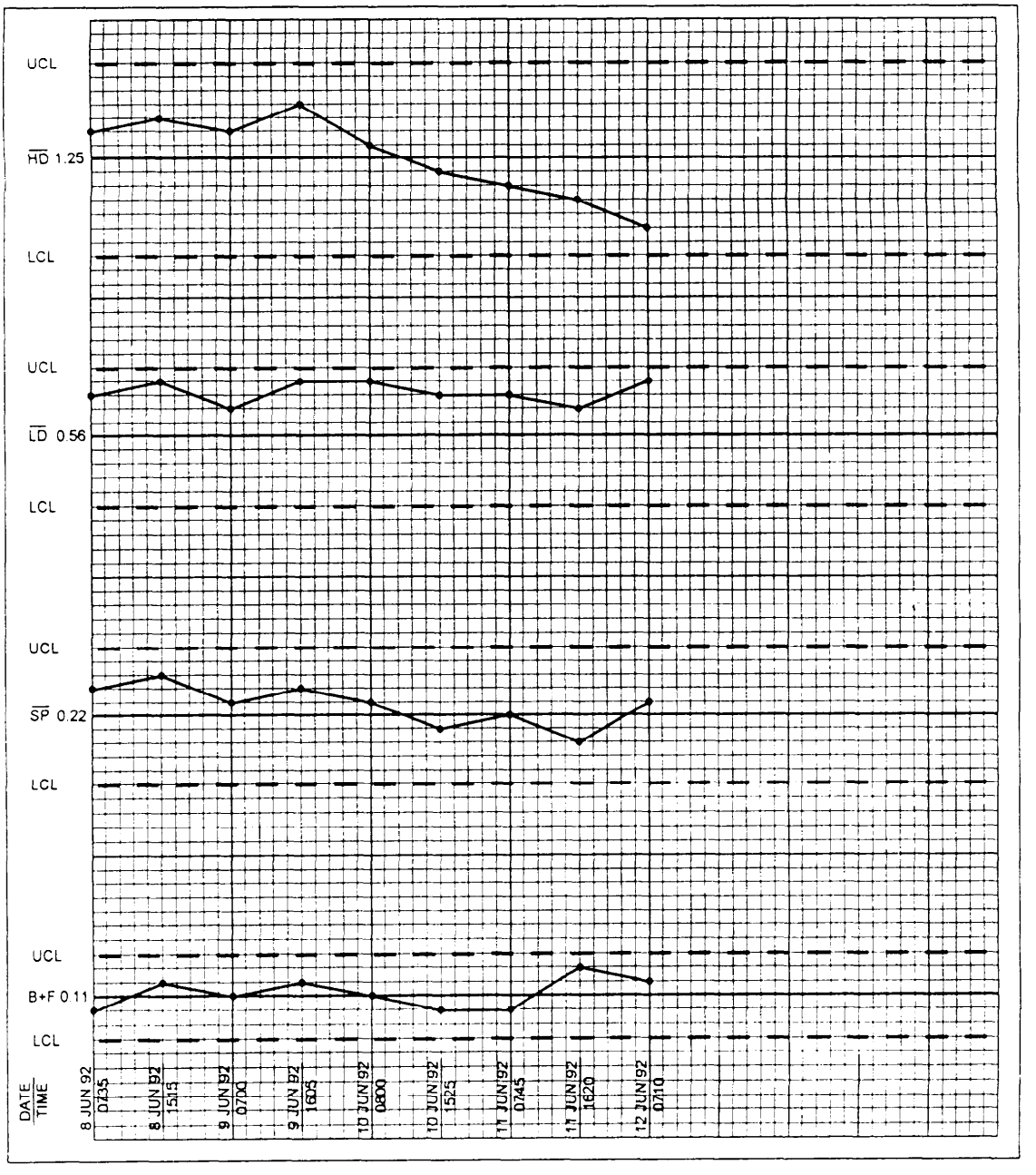


Figure 10-28.–Process control chart.

Refer to figure 10-28. For example purposes only, the following steps are monitored and plotted on a control chart below. The steps being monitored are as follows:

- High density (HD) is step 17 and reads 1.20.
- Low density (LD) is step 6 and reads 0.60.
- Speed point (SP) is step 4 and reads 0.23.
- B+F is 0.12.

When plotting a control strip, you should always annotate the date and the time the control strip was processed. When all points plot within the upper and lower control limits, the film can be processed. When any point plots outside the upper control limit (UCL) or lower control limit (LCL), the process is out of control. You should notify your supervisor before processing any material through that particular process.

CHAPTER 11

BLACK-AND-WHITE PRINTING

In photography, printing is the term used to describe the process of making positive images from negatives (and in some instances, from film positives). The most familiar example is the print made on a paper base. A photographic print is made by passing light through the negative onto a piece of paper coated with a light-sensitive emulsion, very similar to film.

The two primary methods of making photographic prints are **contact printing and projection printing.** The principal difference in the two methods is the method of exposing the paper. In contact printing, the paper is physically in contact with the negative; while in projection printing, the paper is separated from the negative, and the image of the negative is projected onto the paper by a lens. Because projection printing is usually used to produce an enlarged image, it is generally referred to as enlarging. Contact printing produces positive images that are the same size as the negative images. Enlarging usually produces positive images that are larger than the negative image; however, because optics are used in projection printing, the image formed on the paper can also be made smaller or the same size as the negative image.

The quality of the photograph can be varied during printing through the choice of printing material, exposure, and processing. In printing, some negative defects may be compensated for, thereby eliminating the reproduction of the defect in the print.

A well-planned, black-and-white or print room should have at least the following material and equipment arranged properly so the flow of work moves easily from one stage to another:

- A contact and/or projection printer (enlarger)
- A sink large enough to accommodate the largest trays used in the print room
- Safelights
- A set of print trays
- A graduate
- A thermometer
- Print tongs
- A wall clock with a second hand
- Hand towels

Photographic printing papers are predominantly blue and green sensitive and may be processed under the appropriate safelight conditions. Consult the data sheet packaged with the paper you are using or the *Photo-Lab-Index* for the recommended safelight.

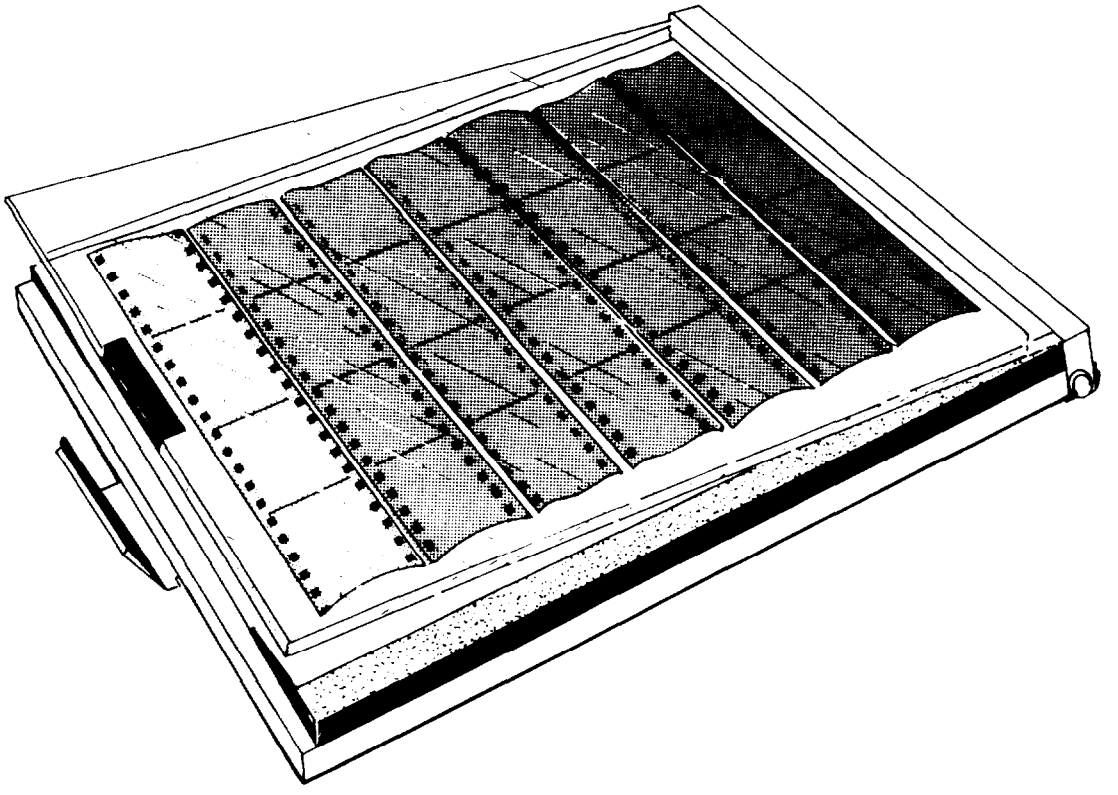
A minimum of three trays are needed for hand processing prints. The trays should be arranged in the sink from left to right-one each for developer, stop bath, and fixing bath. The ideal setup has five trays-one each for developer, stop bath, first fixer, second fixer, and a water rinse. This setup saves chemicals and results in better fixing of prints.

The chemistry used to develop and fix prints is similar to and serves the same purposes as film processing. When processing conditions are controlled carefully, the processing specifications recommended by manufacturers for their printing papers can be used to provide excellent and consistent results.

The print developer used most commonly in Navy imaging facilities is the llford Multigrade developer. The recommended tray processing developing times vary with the type of paper and developer being used. With the developer at 68°F, resin-coated paper development is complete in about 2 minutes. The image appears in about 30 seconds. Because developer is incorporated in the paper, the useful capacity of 1 gallon of Ilford Multigrade developer (diluted 1:9) is about 400 8x10 prints, or equivalent.

Any standard stop bath serves sufficiently. A stop bath may be used at all times, but it is necessary when processing a large number of prints; furthermore, the use of a stop bath after development prolongs the life of the fixing bath. If no acid is available for a stop bath, a water rinse should be used after the developer.

A standard fixing bath should be used to fix the prints. Consult the *Photo-Lab-Index* for the various prepared chemicals available for fixing prints. Follow the manufacturer's instructions when fixing prints because there are adverse effects in over-fixation as well as underfixation. Overfixation tends to produce thinning



303.46

Figure 11-1.–Proof printer.

or bleaching of the photographic image. Underfixation causes the image to darken with time.

WARNING

Never dump fixer down the drain. Dispose of all chemicals according to the local instructions of your imaging facility.

In this chapter, the procedures and techniques for producing black-and-white positive paper prints from black-and-white negatives are discussed. Keep in mind that the procedures and techniques provided are the basics for printing color negatives and positives to produce color prints as well as making duplicate black-and-white film positives.

CONTACT PRINTING

A contact print is produced when you expose a sheet of photographic printing paper through a negative with the paper emulsion and the emulsion side of the negative in contact with each other. Light is directed through the negative which controls the amount of light transmitted to the paper. The dense areas of the negative pass less light than do the more clear or less dense areas. The image densities formed (after development) in the emulsion of the paper make a positive print that represents the tonal values of the original subject. Since the paper is in direct contact with the negative, the print produced is exactly the same image size as the negative.

When you are making a print from a negative by this method, only a 1:1 ratio is obtainable, but contact printing is generally a more rapid means of making prints than enlarging.

The quality of contact prints usually surpasses that of enlargements because there is no scattering of the image-forming light; however, with the ever-increasing use of small film format sizes and since only same-size prints can be made by contacting, enlarging has, for the most part, replaced contact printing in the Navy except for making proof prints.

CONTACT PRINTERS

Contact printing is the quickest, simplest, and most economical method of producing photographic prints. For making proof prints and small volume printing, all a “contact printer” needs is a sheet of glass, a light

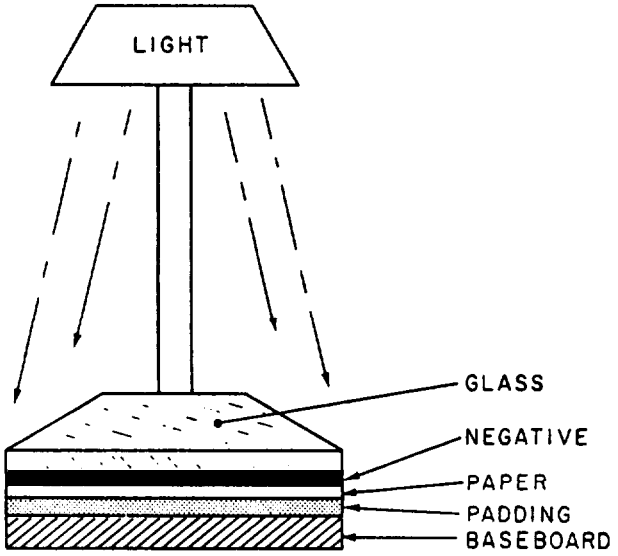


Figure 11-2.–Contact printing arrangement.

source, and some sort of padding. For large volume and fine printing control, a specially designed and constructed contact printer is used

Glass and Pad

For you to make contact proof sheets and an occasional contact print job, only a glass and a supporting pad are necessary. "Contact printers," consisting of a sheet of glass hinged to a metal frame and a pad assembly, are generally known as proof printers (fig. 11-1). When such a device is not available or is not large enough for the negatives to be contact printed, a piece of 1/4-inch plate glass and soft padding (such as a rubber typewriter pad) can be used. Quarter-inch plate glass is heavy enough to keep the negatives and paper flat and in contact during exposure. The glass must be free of flaws, scratches, bubbles, and dirt. For color contact printing, the glass should be water white or crystal grade; otherwise, filtration is required to overcome the color tint of the glass. The edges of the glass should be beveled and the corners slightly rounded or taped. This is a safety measure to prevent cuts when the glass is being handled.

The pad should be at least as large as the glass. The pad provides a cushioned surface to press the paper and negative together under pressure from the glass.

To use either the proof printer or the glass and pad to make contact prints, you should place the printing paper emulsion side up on the pad material. The negatives are then placed emulsion side down on the paper and the glass is positioned on top. Then turn on



303.47

Figure 11-3.–Using an enlarger as a light source for contact printing.

the exposing light (fig. 11-2). This, of course, is done in the darkroom under suitable safelight illumination.

Adequate pressure must be kept on the negative and print paper so their entire surfaces are in contact during the exposure. Any separation between the negative and the paper results in an unsharp point in the image.

The light source may be any controlled lamp for printing with a proof printer or glass and pad. An overhanging light bulb or a safelight, with the filter removed, connected to a timer is a convenient arrangement. In most Navy imaging facility print rooms, an enlarger is used as the light source (fig. 11-3).

Contact Printer

For large volume contact printing, a contact printer is more convenient. A contact printer is basically a box with exposing lights, safelights, and viewing lights inside with a glass top. It has a hinged pressure cover to hold the negative and paper in contact during exposure. Switches on the printer control the lights in the printer or the printer may have a built-in timer. Also, the contact printer may be connected to an external timer.

Contact printers are all built around the same basic idea. However, consult the manufacturer's instructions

that accompany the contact printer for specific operating instructions.

A useful feature on contact printers is an adjustable masking device. This device is attached to the printer so it fits snugly over the printing glass. The mask consists of thin metal leaves used to "frame" the negative. These blades make it possible for the prints to have white borders or margins. To produce prints with white borders when using printers that are not equipped with a masking device, you can use hand-cut masks from thin, black paper.

The basic steps necessary for you to produce a print when using a contact printer are as follows:

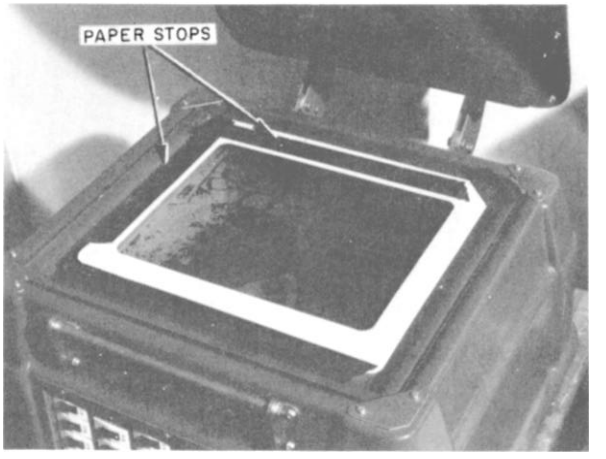
- Place the negative emulsion side up on the printing glass.
- Place the paper emulsion side down over the negative.
- Bring the platen or pressure cover down into the printing position.
- Turn the printing light(s) on for the required exposure time.
- Release the platen, and process the paper.

When you are viewing the negative under a white light, it has a shiny side and a dull side. The shiny side is the film base; the dull side is the emulsion side. A similar examination of photographic paper under a safelight shows that the paper has a shiny side and a dull side. In this case, the shiny side is the emulsion side; the dull side is the paper support. Photographic paper normally has a slight curl toward the emulsion side, although this is not true in all cases.

To make contact prints, you must place the dull side of the negative in contact with the shiny side of the paper; that is, they must be emulsion to emulsion. If the negative base is in contact with the paper emulsion, the photograph will be reversed. In some cases, such a reversal in the print is not easily seen, but it becomes strikingly clear when there are letters or numbers in the picture.

CONTACT PRINTING PROCEDURE

Check the lamp to be sure it is operating properly. Rinse the trays with fresh water, and prepare the developing, stop bath, and fixing solutions. The trays should be larger than the prints to be produced, and one of the largest or deepest trays available should be used for the fixing bath.



303.48

Figure 11-4.–Black tape used as paper stops.

When the solutions are ready, rinse and dry your hands. A supply of printing paper should be available and conveniently located near the printer. Place an empty paper box or paper safe near the printer if the prints are not to be processed after each is exposed. Hold the paper in the paper box or paper safe until the paper is ready to be processed. If the paper is not stored in a paper box or paper safe, it will eventually fog even under safelight conditions.

Masking the Negative

When contact prints require white borders, some type of mask is needed to prevent the printing light from exposing the edges of the printing paper. When the printer is not equipped with a masking device, make a mask to fit the negative. (Usually proof prints do not require masking.) The material used for masks should be opaque and not much thicker than typing paper. When the masking material is too thick it causes a distinct blurring along the edges of the print image.

Some type of guideline or paper stop is useful when placed at one end and one side of the mask opening. The paper stop forms a square-corner guide for alignment of the printing paper. The paper guide helps you to place the paper evenly and parallel with the opening in the mask, and it helps keep the borders even on the print (fig. 11-4). The corner guide or stops can be quite thick without causing poor contact between the negative and the printing paper during exposure. Some printers are equipped with metal strips, so you can mask the negatives by setting the strips to frame the negative.

The negative and printing glass must be cleaned before you place the negative on the printer. Place the negative emulsion-side up on the printing glass and arrange them under the mask until the desired composition is obtained. When you must make more than one print from the same negative, tape the negative (at the corners only) to the printing glass. If the negative is completely taped down, air can be trapped between it and the glass. When the platen or pressure cover is moved into the printing position, the air does not escape. This results in an unsharp print. When you use a hand-cut mask, tape the mask to the glass along one edge before positioning the negative.

Printing Filter Selection

The first requirement for you to make a good print is a clean negative. The negative must then be examined to determine the contrast (flat, normal, or contrasty) and the approximate exposure time required to produce a quality print. As a beginning darkroom worker, you may not be able to make these determinations accurately; however, in a short time and with a little experience, you should overcome any trouble.

In analyzing a negative to determine the most suitable printing filter, be careful not to confuse contrast with density. When in doubt, make test prints. If the test print is contrasty, you should make another test print with a lower numbered filter to lower the contrast. If the original test print lacks contrast, change to a filter with a higher number to increase the contrast. This is a good time to review the information on printing filters and printing papers in chapters 2 and 3.

Test Print

The printing exposure is the operation most likely to cause trouble for an inexperienced darkroom technician. Unlike most films that can tolerate some overexposure and underexposure and still yield usable photographs, printing papers must be exposed correctly to produce good prints.

Experience and familiarity with printing equipment does help; but for a beginner, the correct exposure for prints from most negatives is best determined by making test prints.

The factors that affect exposure are as follows:

- The intensity of the printing lights
- The distance between the printing lights and the printing glass
- The sensitivity of the printing paper
- The density of the negative

The first three factors are standardized and, therefore, eliminated as variables by using the contact printer and by printing with the same type of paper. The only remaining variable is negative density. You can determine negative density by making a few test exposures. The exposure time for a negative of average density may be about 1 to 3 seconds. When the negative is large, avoid the expensive and wasteful temptation of using a whole sheet of paper; instead, use a strip about 2 inches wide and as long as the negative for the test exposure. For example, an 8x10 sheet of paper can be cut into three or four small strips.

After you have determined the filter and the test-exposure time, set the timer accordingly. Place the paper test strip over the negative in the printing position. Place the test strip on the negative so the test exposure includes some highlights, midtones, and shadow areas. Hold the paper in position with one hand and lower the platen. As soon as the platen grips the edge of the paper, move your hand away. When the platen is fully lowered, turn on the printing lights for the test-exposure time.

When the test strip has been exposed, develop it for the recommended time. If the image is too dark, the exposure was too long. If the image is too light, the exposure was too short.

It is difficult for even an experienced photographer to judge the contrast of an under- or overexposed print that has been under or overexposed. Before attempting to judge the contrast of a print, you must change the exposure until the proper density is reached. A normally exposed print develops gradually, but steadily-shadows first, then midtones, and finally highlights. The image should appear in about 30 seconds, providing the developer is at the proper strength and temperature. If the image develops very quickly with a general mottling, it is overexposed and the next test should be given less exposure. An overexposed print develops in a very short time, and the common temptation is to “pull” (remove) it from the developer. This prevents the image from getting too dark, but results in a flat, muddy, uneven, tone image. On the other hand, when the recommended development does not produce a print of the proper density after 2 minutes, the print is underexposed. After you have successfully exposed and processed a few prints, you will rapidly gain enough experience to estimate, closely, the density of negatives for contact printing exposures.



PH2 Noel R. Guest
303.49

Figure 11-5.–A processed test strip used to determine exposure.

When a change in exposure time does not produce a print of good contrast, a different printing filter is needed. When a properly exposed and developed test print lacks clean highlights and shadows, try a higher number of printing filter. When the print is mainly black and white with few middle tones, use a lower number filter. Once you have produced a satisfactory test print, you can make the production prints from that negative.

If you use a printing frame (glass and pad or proof printer) to make contact prints, the most convenient and economical way to determine exposure and correct contrast is to expose the test strip in progressive steps of say 2, 4, 6, and 8 seconds. You do this by holding an opaque card on top of the glass and covering three quarters of the paper and exposing one quarter of the paper for 2 seconds. Then move the card to cover one half of the paper and give it an additional exposure of 2 seconds. Move the card so it covers one quarter of the paper and give it another 2 seconds of exposure. Finally, remove the card and give the entire sheet one last exposure of 2 seconds. This shows a distinct progression of exposures of 2, 4, 6, and 8 seconds (fig. 11-5). Develop the test strip normally. To determine the correct exposure, you must examine the test print under white light.

When the correct exposure appears to be between two steps, the required exposure can usually be estimated with some accuracy; however, additional test prints may be needed.

After the exposure time and contrast for one negative have been determined by tests, other negatives of similar density and contrast can be given the same filtration and exposure as a starting point. At first, negatives with widely differing contrast and density require test prints. With experience, you can judge most negatives without resorting to test prints.

Exposing and Processing Prints

When a test print develops in the recommended time, rinse it in the stop bath, immerse it in the fixing bath for about 30 seconds, rinse it in fresh water, and inspect it carefully under white light. When the density and contrast of the image look correct under white light, make your first “straight print.”

Place the sheet of printing paper, emulsion-side down, over the negative in the printing position by aligning the edges of the paper with the paper stops on the mask (if a mask is used). With one hand, hold the paper in the printing position with one hand to keep it

from slipping out of place when the platen first presses against the edge of the paper, and start the printing cycle as described previously. After the printing cycle is completed, remove the paper for processing. Any number of duplicate prints can be made by repeating the printing cycle.

Drop the print, emulsion-side down, into the developer. Immerse it immediately with a quick sliding motion while pushing the print under the surface of the solution. Grasp one edge of the print, lift it up, and turn it over. Replace the print emulsion up on the surface of the solution. Push the print under the surface again and leave it under during the remaining time in the developing tray. The print must be immersed rapidly and evenly to prevent air bubbles from forming on the emulsion surface. Be sure that all the emulsion gets wet with the developer in the shortest time. Agitate the print constantly for the remaining developing time.

Each type of printing paper has its own working characteristic. The main difference in each type is the length of time required for the image to develop in a given type and strength of developer. A correct print is one that develops to the proper density and contrast in the recommended time. A print should be exposed so it reaches the proper density and contrast only with full development; otherwise, the tone and appearance of the print will be below acceptable standards. If the exposure is insufficient, the image does not develop to the desired density even with longer developing time. It appears pale and lacking in brilliance. Also, stains may occur when development is carried out too long. Paper developers work more rapidly than those used for films; consequently, print immersion must be quick and even, and agitation should be constant.

When the print is fully developed, lift it out of the developer, drain it momentarily, and place it in the stop bath. After about 5 seconds in the stop bath, lift the print, drain it briefly, and place it in the fixing bath. Agitate it in the fixing bath for a few seconds and examine it for defects that might cause it to be discarded. When the inspection is completed, place it emulsion-side down in the fixer and complete the fixing process. Follow the manufacturer's instructions as to the required fixing time. Fixing for Ilford Multigrade paper is complete after about 30 seconds in fresh fixer.

Some papers have a tendency to float in the fixing bath, especially if the bath is mixed a little stronger than usual. When prints float in the fixer, they should be handled constantly or turned facedown to prevent the emulsion from being exposed to the air. The parts of a print exposed to the air during fixing may become stained

Prints that float facedown should not create problems except for the chance that air bubbles can be trapped under the prints. Air bubbles under a print produce stains and must be prevented. By immersing the prints edgewise and facedown, you eliminate air bubbles.

CAUTION

Never attempt to work backwards through the sink-line process. A few drops of fixer on your hands or from a print will contaminate the developer.

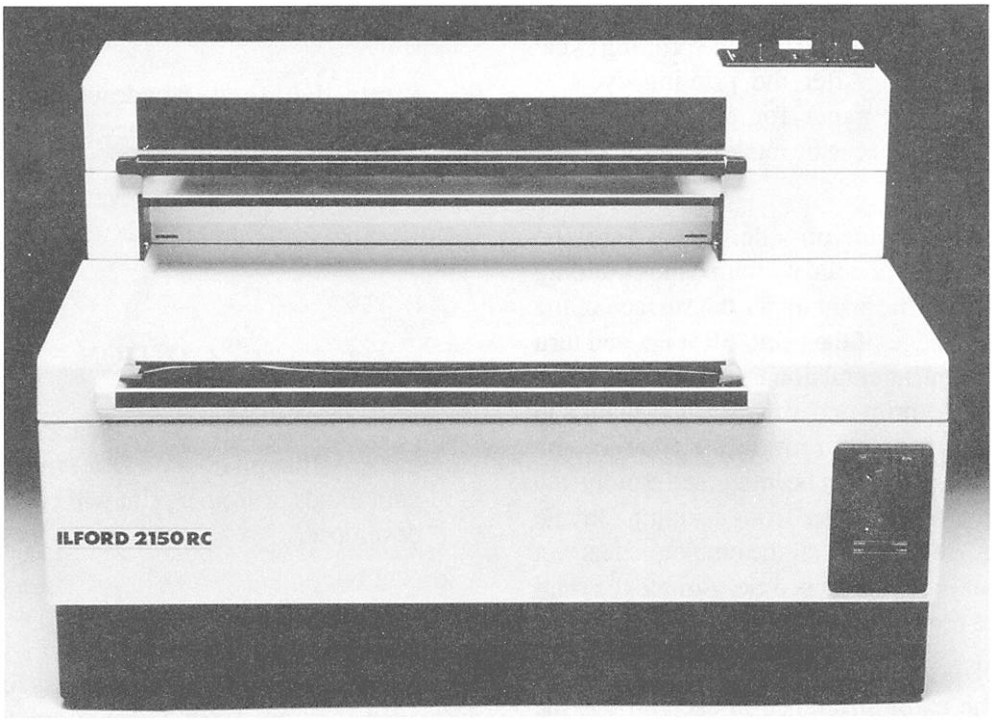
Group Print Development

Several prints can be processed at one time, provided they are separated and agitated sufficiently during the process. Each entire print must be wetted uniformly by the solutions so all parts of each print are processed uniformly.

When you are processing several prints at one time, immerse them in the developer separately at regular intervals and, at the end of the proper developing time, remove the prints in the same order and at the same regular intervals. To prevent the prints from sticking together, you should let each one be completely immersed before the next print is put in the developer. Agitation should be done by rotating the prints in the solution. To do this, take each print, in turn, from the bottom of the tray and place it on top of the other prints.

As the prints reach full development, transfer them one by one to the stop bath. Treat them for 10 to 20 seconds; then place them in the fixer and agitate each print to make sure none of them stick together.

After the prints are fixed, they must be washed and dried. The RC or polyethylene coating on paper prevents absorption; therefore, they require a short wash time. Wash prints for 2 minutes in a good supply of running water to ensure they are completely free of chemicals. The water temperature should not be lower than 41°F (5°C). Prints may be dried in a print dryer designed for polyethylene or RC papers not to exceed 190°F (68°C). Adjust the print dryer to the minimum temperature required to dry the paper sufficiently. If the print dryer is too hot, the polyethylene coating on the paper will melt. When a paper dryer is not available, remove the excess water and dry the prints naturally at room



Courtesy of Ilford Photo
302.307X

Figure 11-6.–Ilford 2150 black-and-white paper processor.

temperature. The prints should be dry in 10 to 15 minutes.

In the Navy today, most imaging facilities process prints through automatic processors (fig. 11-6). It is important for you to know how to process black-and-white prints in trays, because not all of the small facilities have automatic machines. Like all machines, automatic processors breakdown and require maintenance periodically.

When processing photographic prints through an automatic processor, you feed the unprocessed print into the machine; and within seconds, it exits the processor washed and dried. Your hands never get wet, and you can process a large number of prints rapidly. The two most common black-and-white print processors used in the Navy are manufactured by Ilford and Kodak.

When contact printing an entire roll of negatives that are not consistent in exposure, it is necessary for you to make more than one proof sheet from the same set of negatives. Each sheet of paper should be exposed to print some of the negatives correctly on that roll. The result is a composite proof sheet where all the frames are readable. After all, a proof sheet is a tool to select the best frames for enlargement and delivery to the requester. The proof sheets can be stapled together for filing. This is why, as a photographer, you should strive to expose each and every photograph correctly. Amateur snapshooters can shoot film with wildly varying exposures; professional photographers cannot. A good print shows detail in both the highlights and the shadows.

Cleanliness is essential to produce good prints consistently. Keep a supply of clean towels handy, and wash and dry your hands before handling paper and negatives. Clean, dry fingers should touch only the extreme edges of the emulsion side of these papers. When developer is on your hands, dark fingerprints show on the print. Fixer produces white fingerprints. These fingerprints develop and show clearly on the finished prints. You should use two print tongs–one for the developer and one for the stop and fixing baths.

It is not economical to use minimum quantities of developer. Small quantities oxidize (turn brown) very quickly. Oxidized solutions cannot produce clean, brilliant, pleasing photographs.

PROJECTION PRINTING

Projection printing is the process of making positive prints by projecting the negative image onto photosensitive paper. The projected image may be

enlarged the same size as the negative image or reduced in size. When the print images are larger than the negative images, the process is called enlarging. When the print images are smaller than the negative images, the process is called reducing. Because projection printing is usually used to make positive prints with images larger than the negative, projection printers are referred to as enlargers. The term enlarging generally refers to all forms of projection printing.

Projection printing differs from contact printing because the negative is separated from the paper, and the image is projected by a lens onto the sensitized material The negative is placed between an enclosed light source and a lens. The lens receives the light that passed through the negative and projects the image onto the paper. Changing the distance between the lens and the paper controls the size of the image. The image is focused on the paper by adjusting the distance between the negative and the lens. You can enlarge or reduce the size of the projected image by changing and adjusting these distances.

Enlarging is a very adaptable and versatile process, because considerable image and exposure control can be used. The main advantage of enlarging over contact printing is large prints can be made, but there are several other important advantages. The advantages of projection printing are as follows:

- Cropping or selecting the main area of interest in a negative can be enlarged to any suitable size. This provides an opportunity for you to eliminate unwanted and distracting elements from around the point of interest of the picture.

- Dodging or burning in. This allows you to apply local exposure control to bring out more detail in the highlight and shadow areas.

- Local fogging with a small external light, such as a penlight, to darken selected areas; for example, by darkening the background of a portrait, you direct the viewer's attention to the face.

- Special effects can be performed, such as changing the appearance of the image by use of diffusers or patterns between the lens and paper.

- Image distortion correction or introduction can be done by tilting the enlarger easel. (An easel is the device used to hold the paper during exposure.)

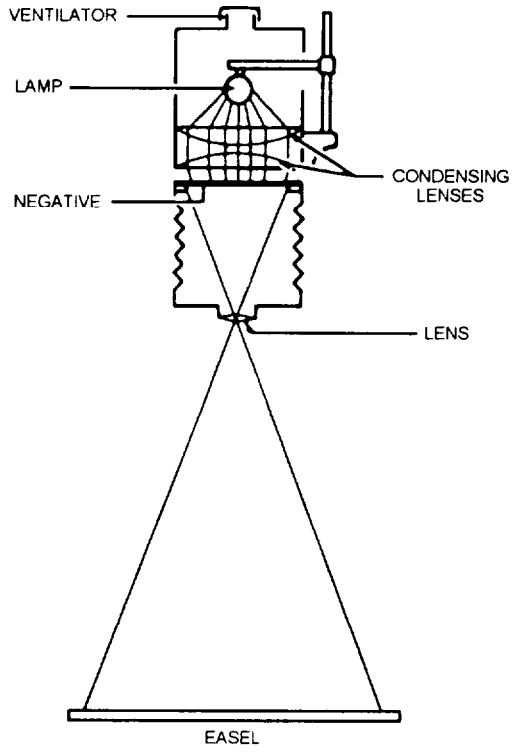


Figure 11-7.–Basic enlarger.

ENLARGERS

In general, all enlargers are similar in design and operation. They have an enclosed light source, some method of providing an even distribution of light over the negative, a negative carrier, a lens, a means of adjusting the lens-to-negative and lens-to-paper distances (fig. 11-7). The degree to which the image is enlarged can be referred to in terms of diameters; for example, a two diameter or 2X enlargement is twice the length and twice the width of the negative image, or four times the area A three diameter or 3X enlargement is three times the length and width of the negative image, or nine times the area.

Most enlargers have a tungsten lamp as a light source. The lamp is enclosed in a lighttight housing that is ventilated to prevent excessive lamp heat from damaging the negative. Some enlargers have blowers to circulate air and cool the inside of the lamp housing.

The negative carrier used in an enlarger may be either a dustless type or a glass sandwich type. The dustless type of carrier is made of two metal plates with an opening in the center large enough to hold the negative. The negative is placed between these plates and held in position by its edges. This type of carrier is good for negatives 4x5 or smaller, since these negatives are stiff enough to remain flat. The glass sandwich type

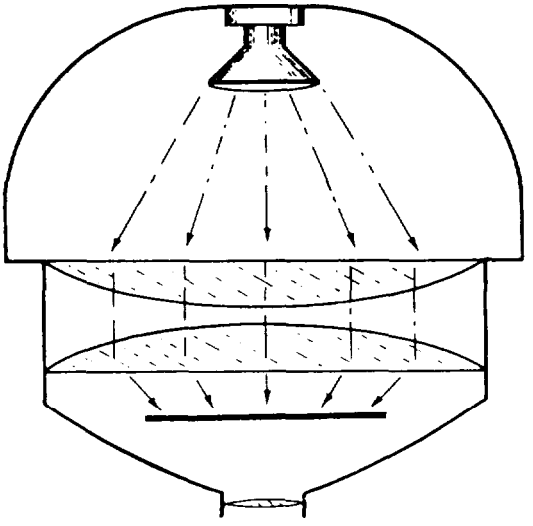


Figure 11-8.–Condenser enlarger.

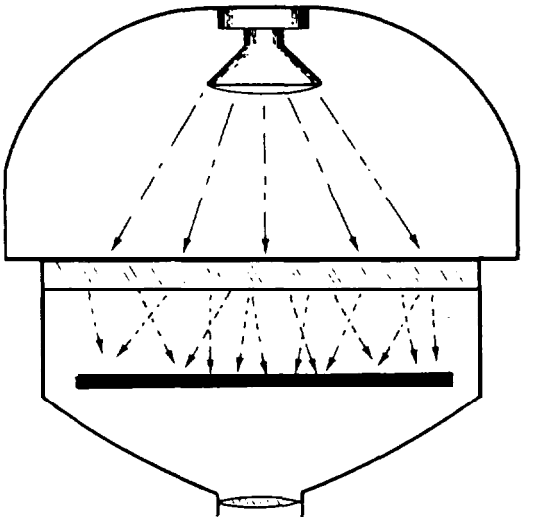


Figure 11-9.–Diffusion enlarger.

of carrier is a holder where the negative is placed between two sheets of glass. This type of holder is used for larger negatives since they have a tendency to sag in the center when they are not supported by glass.

The lens used in an enlarger should have an angle of field large enough to cover the negative being printed. A lens with a focal length approximately equal to the diagonal of the largest negative to be printed provides sufficient angle of field.

The bellows of an enlarger should be capable of extending at least twice the focal length of the lens. This amount of bellows extension is necessary for making 1:1 reproductions. Although it is possible to make reductions to any desired size, the bellows on most enlargers cannot be extended far enough to make reductions smaller than 1:1. Smaller reductions can be made by using a longer focal-length lens, but a better method is to use a reducing attachment. A reducing attachment consists of a section of supplementary bellows fitted with a longer focal-length lens.

The systems used to distribute the light evenly over the negative divide enlargers into three general types–condenser, diffusion, and condenser-diffusion enlargers.

CONDENSER ENLARGERS

A condenser enlarger has a set of condensing lenses between the light source and the negative. The condensing lenses concentrate or focus the light from a light bulb and direct the light rays straight through the negative to the lens (fig. 11-8).

The condenser lenses are a pair of planoconvex lenses mounted as a unit with their convex surfaces face to face. A condenser enlarger produces a sharp, brilliant image and produces higher contrast and detail than diffusion enlargers. Negative defects and scratches are more apparent in the print when made on a condenser enlarger.

The characteristics of a condenser enlarger are as follows:

- It produces maximum tone separation.
- It is suitable for making prints to a high degree of enlargement, because of its optical characteristics.
- It produces a higher image contrast with a given negative than printing with a diffusion enlarger.
- It is not recommended for negatives that have been retouched, because the edges and ridges of the retouched areas may print as dark lines.
- It may be used to emphasize negative defects and silver grain structure.

DIFFUSION ENLARGERS

A diffusion enlarger has a diffusion screen (usually ground or optical glass) between the light source and the negative. Light from the lamp, as well as the light reflected from the reflector of the lamp housing, falls on the diffuser that scatters the light. After the light passes through the diffuser, it travels in many directions when it falls upon the negative (fig. 11-9).

When a diffusion enlarger is used, negative defects are not recorded as clearly in the print, compared to condenser enlargers. There is an apparent overall "softening" of the image sharpness and a reduction in image contrast.

Most of your negatives can he enlarged equally well with either a condenser or diffusion enlarger; however, for certain work the choice of enlarger may be an important factor.

The characteristics of a diffusion enlarger are as follows:

- It should be used for printing negatives that have been retouched.
- It subdues negative defects and grain.
- It has less image contrast than that produced with a condenser enlarger.
- It is not suitable for making large prints due to the softness of the image produced.

Diffusion enlargers should be considered for use in portraiture and when the negatives have been retouched.

CONDENSER-DIFFUSION ENLARGERS

A condenser-diffusion enlarger or semidiffusion enlarger is a compromise between the two extremes of condenser and diffusion. A condenser-diffusion enlarger uses a diffusion (frosted) bulb and condensers, or a diffusion bulb with either a diffusing glass over the condensers, or else one of the condensers itself acts as the diffuser.

A condenser-diffusion enlarger has the advantages of a diffusion enlarger to reduce the effects of negative defects, silver grain structure and dust, and it also uses the condenser system for speed and uniformity of light.

The enlargers in general use by most Navy imaging facilities are the condenser-diffusion type. They use frosted or diffusion bulbs with or without a diffusion screen placed above the condensers.

ENLARGER LENSES

As with a camera, the lens of the enlarger is the heart and should be high quality and reasonably fast. It is senseless to buy high-quality lenses for the camera, then nullify the quality they provide with an inferior enlarging lens; however, a quality camera lens is not suitable for enlarging. Even a moderately good enlarging lens is better for enlarging than most camera lenses.

Table 11-1.–Enlarging Lens Focal Lengths for Various Negative Sizes

Negative size	Lens focal length
35mm	50mm
120 (2 1/4 x 2 1/4) (6x6cm)	75mm
120 (2 1/4 x 2 3/4) (6x7cm)	105mm
4 x 5 inch	135-150mm

The focal length you use with an enlarger should be based on the size of the negative to be enlarged. (See table 1l-1.) Generally speaking, the focal length of the enlarging lens for a given negative size should be the same as a normal-focal-length lens used by the camera for the negative.

While it is not necessary for the lens to cover the full area of the negative, the longer the lens focal length, the less magnification at a given lens-to-paper distance; therefore, you must have several lenses of various focal lengths available for your enlargers when you want to make large prints from small portions of your negatives.

Because an enlarger produces an image from a flat field (the negative) onto a flat field (the paper), depth of field is not a factor, except when distortion control (discussed later) is used. An enlarger lens can usually be used at large f/stops; however, when an enlarger lens is used at its maximum aperture, there may be some falloff of light at the edges of the circle of illumination. Therefore, an enlarger lens is usually stopped down one or two f/stops from wide open. Like a camera lens, when an enlarger lens is used at very small apertures, there is a loss of image definition due to diffraction.

ENLARGING PROCEDURE

The darkroom design, the equipment, and the arrangement for enlarging are basically the same as for contact printing. The safelights should be appropriate for the type of paper being printed. The size of the prints may require larger trays and greater amounts of solution, but they should be set up in the sink the same as for contact printing.

To produce good enlargements, you need good negatives, a clean enlarger, clean printing filters, correct exposure and development, and careful processing and finishing. Although most negatives can be printed by projection, there are a few desirable characteristics. A

good negative has normal density and contrast. It must be sharp and free from such defects as scratches, abrasions, dust, lint, and fingerprints.

ENLARGER AND EASEL ADJUSTMENTS

Insert the negative in the negative carrier so the emulsion side is down when placed in the enlarger. In other words, the base of the negative (the shiny side) should be up or facing the lamp when inserted into the enlarger. Clean the negative and be sure there is no dust on it. You can use the light from the enlarger to check for dust. Blow off any dust with a bulb syringe or low-pressure air. Then, use a camel-hair brush to brush or lift off any remaining dust. Replace the negative carrier containing the negative into the enlarger; ensure it is seated properly.

Set the paper guide or masking device on the easel to form the border width needed or use a preset easel. As an aid for composing and focusing the image accurately, place a sheet of white paper in the easel-the base side of the paper is used for a focusing sheet-then turn out all white lights.

Turn the enlarger lamp on, open the lens to its maximum aperture, and move the easel around until the desired portion of the image is in the picture area Raise or lower the enlarger head on the upright standard or column and focus the image. Shift the easel as needed, and continue these adjustments until the image is enlarged (or reduced) to the desired size, focused sharply, and composed on the easel correctly.

The size of projection prints is limited by the optical system used and the working space available. A scene may be printed in sections on several sheets of paper and spliced together. Likewise, the enlarger can be turned 180 degrees and projected on the floor. If you use this baseboard method, be sure to counterweight the enlarger by placing a heavy weight on the baseboard to prevent the enlarger from tipping over.

The picture is easier to compose with the scene right-side up. When it is upside down from your point of view, the negative carrier should be rotated or removed and the negative repositioned. The image appears right-side up on the easel when it is positioned upside down in the negative carrier.

You should adjust the easel until the best composition is obtained. When composing the image, try to correct errors of image composition in the negative. The way the scene is composed on the negative may be a controlling factor in the final composition. Straighten the horizon, and when possible, prevent it from cutting the print image in half. When the horizon is not to be included in the print, make sure vertical objects are parallel to the sides of the print. When the space around the point of interest of the picture is distracting, you can change the composition of the picture through cropping. You can do this by increasing or decreasing the magnification of the image and by readjusting the easel.

After the image is correctly composed and focused, the lens aperture should be stopped down so your basic exposure time is about 10 seconds. An exposure time of 10 seconds allows you to accomplish a normal amount of dodging and is fast enough to be practical for quantity production. The exact amount the lens should be stopped down depends on the density of the negative and the magnification of the image. This can be difficult to determine without experience. If you are new to printing, you should start by stopping down the lens to about f/5.6 or f/8 for a normal negative.

MAKING A TEST PRINT

There are many factors that affect exposure times in the enlarging process. Some of these factors are as follows:

- The light source and illumination system of the enlarger
- The f/stop of the lens
- The density of the negative
- The degree of enlargement
- The speed of the paper
- The density and color of the contrast printing filter

The best way for you to determine the correct enlarging exposure is by making a test strip. Although the test strip is the most reliable way to determine exposure, you do not need a test strip for every enlargement. It is, however, a wise practice whenever you are in doubt as to the exact exposure required.

A test strip for enlarging is made the same way as for contact printing. When making the enlargement test strip, you must try to select the proper printing filter based on negative contrast.

Once the printing filter has been determined, set the enlarger for producing the desired size prints. Set the lens f/stop at f/5.6 or f/8, for example. Next, examine

the projected image on the focusing paper in the easel and estimate the amount of exposure time you think the print requires. From experience, you estimate the correct exposure time to be about 15 seconds. Because your estimate may be incorrect, a logical procedure is to expose a test strip in four sections.

To make the actual test strip, you must do the following:

1. Place one test strip on the easel in a position to sample the highlights, midtones, and shadows.

2. Cover three quarters of the strip with opaque paper or cardboard and expose the uncovered section for 5 seconds.

3. Move the cardboard to cover one half of the strip and give another 5 seconds of exposure.

4. Again move the cardboard-this time to expose three quarters of the strip-and provide 5 seconds of exposure.

5. Now uncover the entire strip and expose it for another 5 seconds. This produces a strip with exposures of 5, 10, 15, and 20 seconds.

6. Process the test strip the same as contact prints.

7. Examine the processed test strip under white light and select the segment representing the exposure that gave the best results. If a time between two sections gives the best result, make another test at the estimated time. When you have selected the exposure, you are ready to make a full-size print-if the contrast is correct. If not, change filters and make another test strip.

The primary purpose for a test print is to determine the correct exposure, but it can also help you determine the correct contrast or printing filter to use. When the test print is too contrasty or too flat, make another test print with a higher or lower number of contrast printing filter.

When printing, contrast (the difference in tonal value between the highlights and shadows) is as important for you to determine as is the correct exposure. Almost all Navy imaging facilities use variable contrast printing papers. To control contrast with this type of paper, you must use variable contrast printing filters.

Unlike film, increasing the development time of paper does not increase the contrast significantly. In fact, when paper development is carried out much beyond the recommended time, contrast can actually decrease due to fogging. Likewise, short development times should not be used in an attempt to get lower contrast. The result of short paper development times is usually a print that is not fully developed, and the print has poor tone quality and a "muddy" appearance.

Table 11-2.–Multigrade Filter Selection Guide

Filter Number	Use
00	Normal prints from very contrasty negatives. Produces very flat prints from normal or low-contrast negatives.
2	Normal prints from normal negatives, flat prints from low-contrast negatives, and contrasty prints from contrasty negatives.
4	Normal prints from low-contrast negatives, and contrasty prints from normal or high-contrast negatives.
5	Normal prints from very low-contrast negatives, and very contrasty prints from normal negatives.

Variable contrast printing filters are the only practical way of altering print contrast with variable contrast papers. Variable contrast papers have orthochromatic sensitivity. The blue light-sensitive part of the emulsion controls high contrast, and the green light-sensitive part controls low contrast. By using the proper variable contrast filter between the light source and the paper, you can control the contrast. Variable contrast filters range from yellow (low contrast) through deep magenta (high contrast).

When making test strips to determine correct exposure, you also need to determine the contrast. You do this by examining the shadow area of the test strip that has the correct highlight exposure. When the shadow area of this test is too light, the test does not have enough contrast. When the test does not have enough contrast, a higher number filter is required. When the shadow area is too dark, the test has too much contrast and a lower number filter is required.

Table 11-2 is based on using Ilford Multigrade filters and Ilford Multigrade papers. Ilford Multigrade filters are available in the following 12 grades: 00, 0,



PHC Carl Hinkle
302.308

Figure 11-10.–Comparison of a number 0, 2, and 5 contrast printing filter.

1/2, 1, 1 1/2, 2.2 1/2, 3, 3 1/2,4,4 1/2, and 5. Use this table as a guide to help you determine the correct filter. The principles, also, apply to the use of filters not shown in the table, such as 0, 1, 1 1/2, 2 1/2, 3, 3 1/2, or 4 1/2.

Figure 11-10 shows the difference in contrast obtained from one negative using different contrast printing filters.

When using variable contrast paper and filters, you must remember the following:

- The filters should be clean and in good condition (not scratched, etc.). Like all filters, they fade and must be replaced.

- The density of filters changes with the different numbers. Filter numbers 0 - 3 1/2 require a one f/stop increase of exposure compared to the exposure when no filter is used. Filter numbers 4 - 5 require a one f/stop increase compared to the exposure when a 1 - 3 1/2 filter is used, or a two f/stop increase of exposure compared to the exposure when no filter is used. For example, when you make a test print with an exposure of f/8 at 10 seconds with a No. 3 contrast printing filter, and then make another test print with a No. 4 contrast printing filter, your new exposure will be f/5.6 at 10 seconds.

- It is possible to control local contrast by changing filters. For example, one possibility is for you to print an overall exposure with a No. 2 filter while holding back or dodging the sky and then burning in the sky with a No. 1 filter. When printing with more than one filter, you should work from a full test print to determine the best approach.

- Study the manufacturer's directions so you can use their filter and paper combination to best advantage.

Many of us are guilty of throwing away the manufacturer's directions that come with photographic materials. By maintaining them in a reference book, you have a tremendous source of information available that can save time and materials.

Having determined the correct exposure and contrast, you are now ready to produce the production prints. Until you become proficient in printing, make test prints for each negative you print.

By adjusting the lens f/stop, you may use longer or shorter exposure times than the test exposure time determined previously, providing they do not become excessive in either direction. Very short exposures are not practical. Very long exposures subject the negative to excessive heat from the printing lamp and also waste time. Five seconds is the minimum amount of exposure time that you should use. Twenty seconds is about the longest exposure time required for normal negatives. A standard procedure is to change the exposure by varying the f/stop of the lens to bring the exposure time within practical limits.

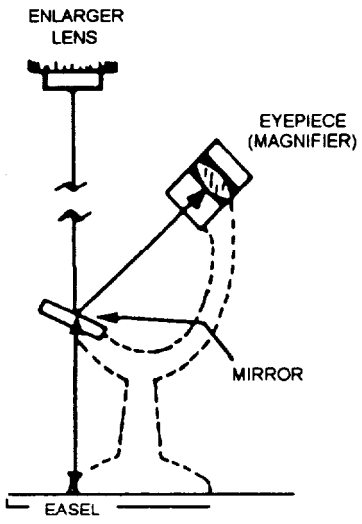


Figure 11-11.–Grain focuser.

GRAIN FOCUSER

Focusing the negative image on the enlarging paper can be difficult when the negatives are dense or have no sharply defined lines that you can see in the projected image.

Focusing is easier and more consistent when you use a magnifier or grain focuser. A grain focuser magnifies the negative grain structure by 10X to 25X. This magnification allows you to focus the actual grain structure of the image. A grain focuser provides you with the sharpest focus you can get from a given negative.

The projected image of the negative is reflected by the mirror of the grain focuser to the eyepiece. The distance from the mirror to the eyepiece is equal to the distance from the mirror to the easel (fig. 11-11); therefore, when you see a sharp image of the grain structure in the magnifier, the image projected on the easel is equally sharp. The area of the negative visible in the magnifier is extremely small. You are not actually looking at details of the image but at the grain structure of the negative that actually produces the image.

To use the grain focuser, you should enlarge and compose the picture normally on an easel. Place the grain focuser on the easel with a sheet of focusing paper in it, so a central portion of the projected image reflects from the mirror into the eyepiece of the grain focuser. Examine the grain structure through the eyepiece and adjust the fine focus until the grain structure is in absolutely sharp focus.

CREATIVE CONTROLS IN PRINTING

Because of the many ways you can control the final appearance of the photograph, enlarging is a creative procedure. You can use printing exposure to make your prints lighter or darker, and the contrast can be altered by your choice of printing filters. You, also, have other creative controls available, such as cropping (composition), dodging, printing, or burning in, vignetting, diffusing, correcting image distortion, and so on.

You should devote as much attention and care to printing as to making the original negative; otherwise, you do an injustice to your skill and reputation as a photographer.

COMPOSITION AND CROPPING

Printing only a part of the entire image recorded on a negative is called "cropping." Cropping is the procedure in printing used to improve the composition of the photograph. Most photographs are intended to present an idea or provide the viewer with some type of information. The better the composition of the finished picture, the better it communicates the intended message.

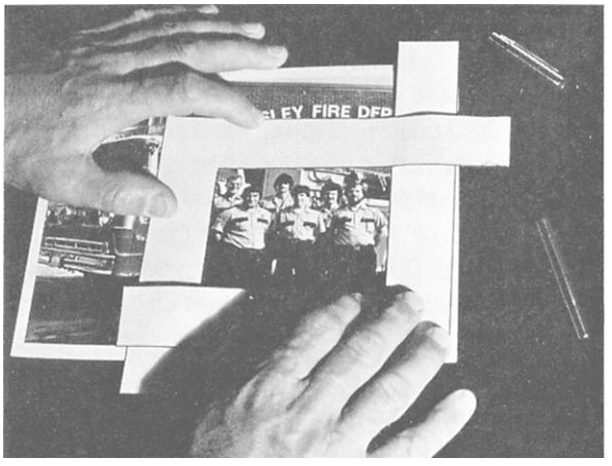
Photographic composition should be controlled or established with the camera when the picture is taken; however, the majority of photographs can be improved during the printing process by cropping. You can use cropping to eliminate distracting or unwanted scene elements, to straighten a tilted horizon, to alter the center of interest, or to strengthen leading lines.

Since personal opinions differ, there are no hard-and-fast rules for cropping; however, the following are rules of thumb that may help you produce pictures that are pleasing to most people:

- Crop out any elements at the edges of the picture area that may draw attention from the intended center of interest.

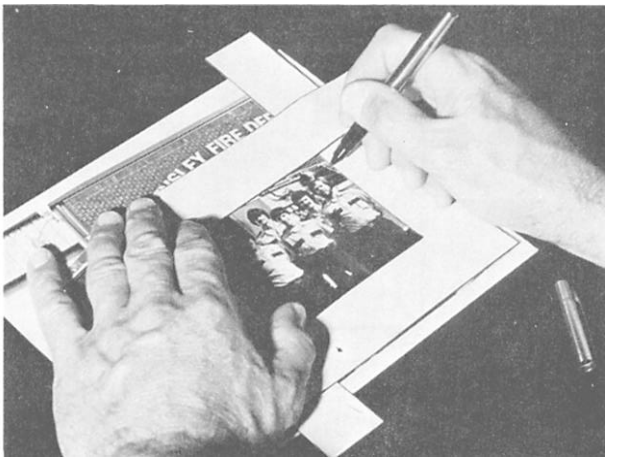
- The center of interest should not normally be located in the physical center of the print. The center of interest should be somewhat to the left or right and a little below or above the physical center of the picture. The exact location for the center of interest depends on the subject and the format of the print.

- Horizontal, vertical, and diagonal lines should not divide the photograph into equal parts. The horizon in a photograph should be absolutely horizontal. The vertical lines of buildings, with one exception, should



303.57

Figure 11-12.–Cropping arms can be used to determine cropping.



303.58

Figure 11-13.–Marking the print to be cropped.

be vertical. The one exception is the vertical lines of buildings that naturally appear to converge. In this case, the central vertical line, either real or imaginary, should be rendered as vertical.

- People or animals shown in profile or near profile within a photograph should appear to be looking into the picture, not out of it; for example, the subject should have more picture area in front than behind.

- Unless you are producing micro- or macro-photography, the printed images should not normally be larger than the actual size of the subject.

- The image area of a picture should appear to have a solid support. This effect can sometimes be achieved by printing the lower part of the picture darker than the upperpart

- In a landscape or seascape picture, print the foreground somewhat darker than the middle distance, and print the middle distance darker than the far distance. Then gradually increase the density of the sky from the horizon upward. This creates a feeling or illusion of depth.

A contact print (proof print) of the full negative to be printed is helpful in determining the most effective cropping for the picture.

Have available a set of cropping arms such as the ones shown in figure 11-12. Cropping arms can be cut from pieces of cardboard. Be sure the arms have true right angles. You should use the following procedure to crop or mark the proof print:

1. Place the cropping arms over the proof print and move them about until you have the desired cropping, composition, and picture proportion or format.

2. With the cropping arms held in place on the proof, mark the print with a grease pencil (or other suitable marker) to outline the desired area or composition of the picture (fig. 11-13). You should use the marked proof print as a guide for setting up the enlarger and easel.

3. With the negative in the enlarger and the printing lamp turned on, adjust the enlarger for the desired image size and cropping. Use the proof print as a visual guide.

4. Adjust the adjustable masks on the easel to the correct format and desired cropping. The adjustable masking device on the easel should be adjusted so at least a 1/4-inch white border is left on all four sides of the finished print. Excess border can be cut off the print after it is processed.

> There may be occasions when you may want to produce prints with borders larger than 1/4 inch or with borders of various widths, such as 1/2 inch at the top and sides and 1 1/2 inches at the bottom, or you may want prints without borders or with black borders. To make a print without borders, cut the borders off after the print is processed or use a borderless type of easel.

5. Adjust the picture composition by moving the easel, by changing the border masks, or by changing the picture enlargement or any combination of these until

the projected image is the same as the cropped area in the proof print.

LOCAL PRINT CONTROL

No matter how good your camera work, somewhere in the negative there will probably be areas that do not print correctly. A "straight" enlargement from a negative is seldom the best possible print. When everything has been done to match the negative with the proper printing filter and still the print is unsatisfactory, you may resort to manipulating the light while exposing the paper. This manipulation may be dodging to prevent part of the image from getting too dark or it may be burning-in to produce detail from a part of the negative that is too dense. Local print control can be used to compensate for uneven lighting of the scene photographed or to provide more prominence to a selected part of the picture.

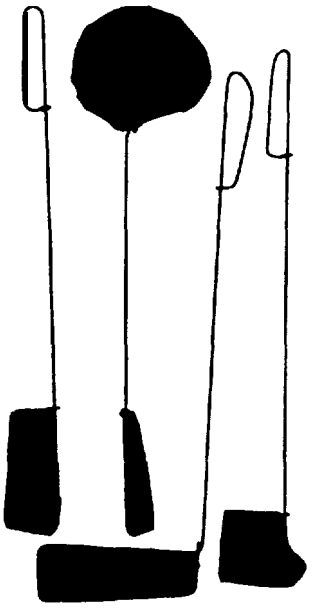


Figure 11-14.–Dodging took.

Dodging

As discussed before in contact printing, you may often find it necessary to dodge or hold back some parts of images to produce the best print. When projection printing, hold the dodging material in the beam of light, so its location and coverage can be seen and controlled during the printing exposure. The dodging tool is placed between the lens and the printing paper so it prevents light from falling on the area being dodged. The shadow area the dodging tool creates may be small or large. The coverage depends on the size of the tool and the distance from the printing paper where the dodging tool is held. Dodging is generally necessary for only part of the total exposure time. The tool being used must be moved constantly to prevent a sharp line between the area being dodged and other parts of the image.

Accurate dodging may be done with your hands or various shaped tools. Your hands, when used as dodging tools, can cast a variety of different sizes and shapes of shadows to hold back unwanted light from the print. Some photographers prefer to use dodging tools, such as a stiff wire with various sizes and shapes of black cardboard or crumpled cellophane attached (fig. 11-14). Another dodging tool is a loop of a thin, stiff wire bent to the desired size and shape. The loop is then covered with black masking tape. Even a plain piece of cardboard can make an effective dodging tool.

Because light is held back from an area during dodging, the dodged area receives less exposure than the surrounding image area. Thus the dodged area of the processed print is lighter than it would have been had dodging not been used.

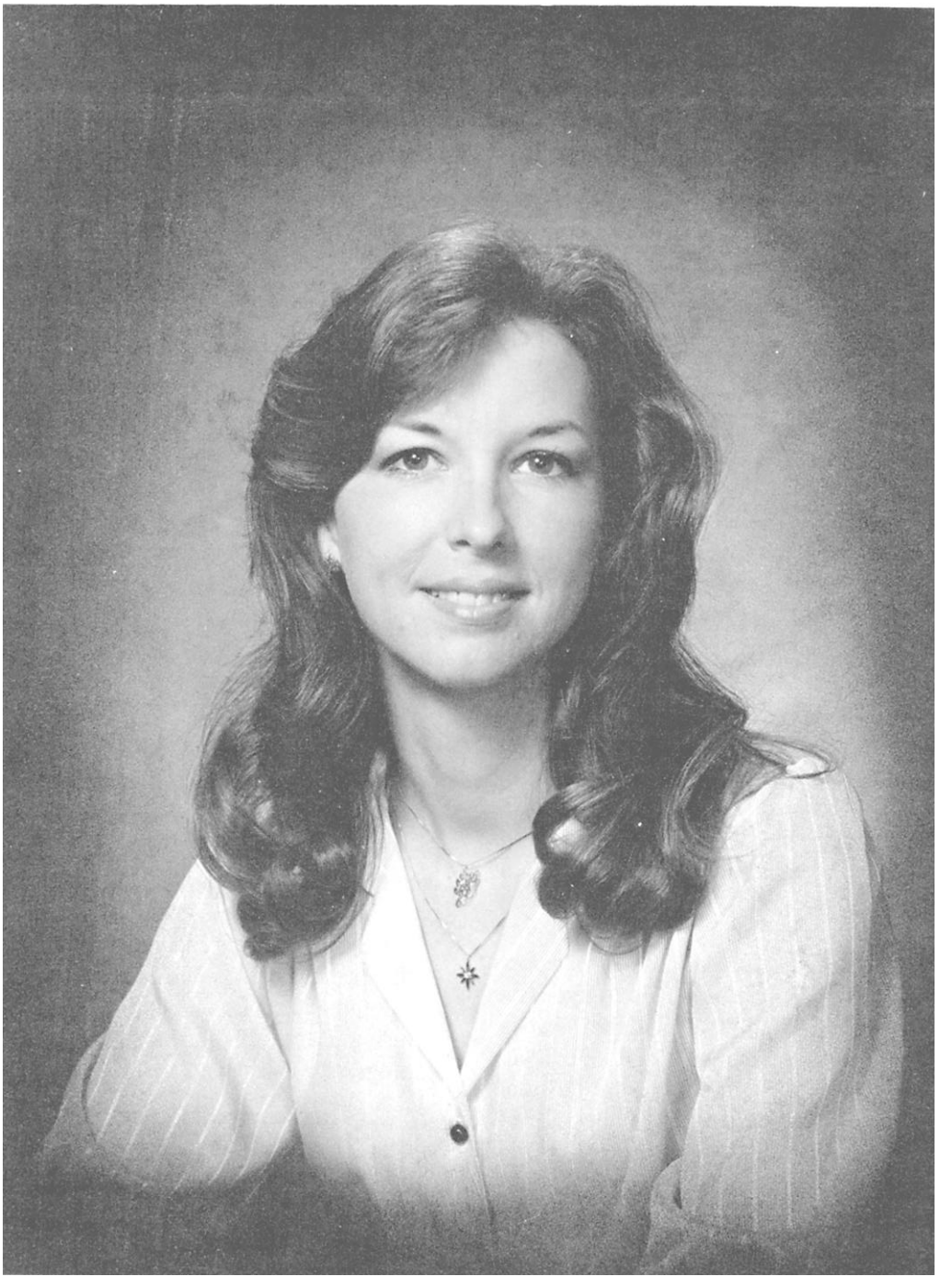
Dodging can be used for creative and corrective effects. It is used to hold back shadow areas, thereby preventing these areas from printing too dark and losing detail; for example, part of a person's face may be too much in shadow because of the hat he or she is wearing, while the rest of the face is brightly lighted. You can dodge or hold back some of the light from the shadow area of the face image; this keeps the shadow from printing dark, and a more pleasing and detailed photograph is produced.

The amount of time you should dodge can vary widely, depending on the subject, the negative, and the overall exposure time. Even an experienced printer may have to produce several test prints to determine the correct amount of dodging.

Remember, to prevent any distinct outline of the dodging tool from reproducing in the print, you must keep the dodging tool in constant motion during the exposure. Use a circular, sideways, or shaking movements to accomplish this.

Burning-in

Burning-in makes an area within a print darker than it would be otherwise. A burning-in tool is usually a piece of cardboard with a hole in the center that is



PH1 Anthony Contos
303.63.2

Figure 11-15.–Vignetted head-and-shoulders portrait.

smaller but approximately the same shape as the area to be burned in. Your hands can be shaped to form a hole to allow light to pass.

A burning-in tool is positioned between the enlarger lens and the printing paper, so light passes through the hole and exposes only that part of the paper you want to print darker. The rest of the image is blocked by either the tool or your hand.

For burning in, the usual procedure is to give the printing paper the overall required exposure during which time any required dodging is performed. Then re-expose the area to be darkened.



PHC Carl Hinkle
302.309

Figure 11-16.–Head-and-shoulders portrait using diffusing techniques.

Some areas of a negative that may require burning in are the dense areas that would otherwise reproduce as pure white with little or no detail or very light gray in the print; for example, a bright sky, a white uniform, a white cake, or highlights on a face.

Like dodging, to prevent an outline of the tool from reproducing, you should keep the tool in constant motion during the burning-in exposure.

Vignetting

In printing, vignetting is a technique that causes the image to fade gradually into the background toward the corners of the print. A vignette effect is produced by projecting the desired negative image area through a large hole cut in a piece of cardboard or by dodging the central image area during part of the exposure time. When the background is to be printed light, the entire exposure should be made through the vignetting card. When the edges of the hole are serrated, the outline of the vignette will be soft and diffused In most cases, a soft, diffused vignette produces the most pleasing result.

Head-and-shoulders portraits are usually the most suitable for vignetting, although vignetting may be applied to other subjects (fig. 11-15). A photograph with a light background provides the most pleasing vignette results. For a head-and-shoulders portrait, the vignetting card should have an egg-shaped hole cut in it. The subject in a vignette should be a little smaller than it is in a straight nonvignetted print. Leave plenty of space around the image. Balance the head-and-shoulders image on the paper by leaving more blank paper below the image than above it. The blank paper at the sides should be about equal, but less than at the top. As with dodging and burning in, the vignetting card must be kept moving during the exposure.

Diffusing

Photographs can be diffused so sharp lines of the image are softened, subdued, or blurred slightly in the reproduction. Diffusion can be used to produce a hazy effect, such as the effect seen on a warm lake in early morning. In printing portrait negatives, diffusion can be used to subdue the reproduction of facial blemishes or wrinkles. The effects of harsh portrait lighting or retouching also may be softened with diffusion (fig. 11-16).

The best diffused enlargements are made using a glass diffusing disk placed under the lens of the enlarger. Other suitable diffusing materials are transparent cellophane, either smooth or wrinkled, or a piece of panty hose, or similar fabric. Dark gray or black is preferable.

The amount of diffusing with a given material is controlled by the distance of the material from the lens of the enlarger and the density of the diffusing material. Diffusing tends to lower image contrast; therefore, you may need to use a higher contrast printing filter than normally required for a given negative. The exposure through the diffusing material should be about one third of the total required exposure time.

To use dodging, burning-in, vignetting, and diffusing effectively, you should make one full-straight (uncorrected) print, using the basic exposure determined with your test strips. Study this print and determine the location(s) you are going to dodge, burn in, and so forth. The application of these techniques may appear time-consuming, but you will make professional-quality prints that are rich in detail and mood.

MINIMIZING GRAININESS

As you know, most black-and-white photographic images on film emulsions are made of fine grains of silver. Because of this silver grain structure, enlargements, especially large ones, may appear "grainy." The graininess of a print is a direct result of the graininess of the negative and the degree of enlargement. The graininess of a print, however, may be modified to a limited extent during the printing stage by the following techniques:

- The diffusion enlarger should be used where negative graininess is serious and objectionable in the print.

- The appearance of graininess in the print can be reduced by using a rough, surface paper instead of a smooth, glossy paper.

- A diffuser used between the enlarger lens and the printing paper helps subdue the appearance of grain. Crumpled cellophane, fine mesh screen, or a piece of nylon stocking can be used as a diffuser.

- The enlarger can be set to project an image that is slightly out of focus.

The permissible graininess in a print depends very much on the viewing conditions. For a large display print to be viewed from a relatively great distance, more graininess can be tolerated as compared to a smaller print held in a person's hand for viewing.

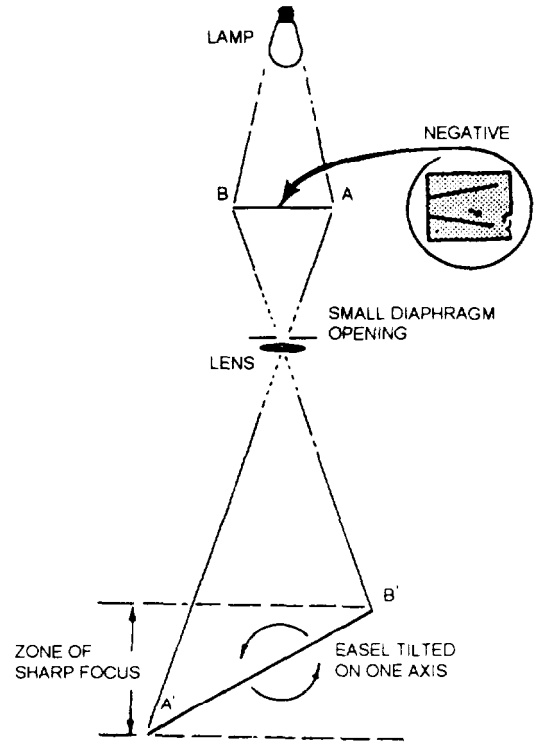


Figure 11-17.–Distortion corrected by tilting the easel.

DISTORTION CONTROL

When you tilt the camera upward to make a picture of a tall building, the vertical lines converge and the building walls seem to be at the point of collapsing. A view camera is equipped with movements that allow the film to be parallel, or nearly so, with the subject, in spite of the viewpoint; however, most of the negatives you print probably are not made with a view camera. Many negatives show an undesirable, noticeable convergence of lines. Changes in these images can be made by tilting the head on some enlargers or by tilting the easel and paper to correct image distortion (fig. 11-17).

Most enlargers have an easel separate from the enlarger. Because the easel is separate, it can be tilted by blocking it up on one end. A small diaphragm opening (high f/stop) must be used to increase the depth of focus to include both the part of the easel nearest the lens and the part of the easel farthest from the lens. Within the limits of what you can keep in focus, you can correct some or all of the distortion. With some enlargers, you can tilt the negative carrier by propping up one side with one or more coins.

One big disadvantage of tilting the easel is that an extremely small diaphragm opening must be used for depth of sharp focus. The use of a small diaphragm opening makes focusing and composition difficult. This makes it necessary to use long exposure times.

PROCESSING DEFECTS

The prints you produce will not be perfect every time. Table 11-3 shows some of the most common defects found in black-and-white prints. Use this table to identify and correct print defects.

Table 11-1-Print Defects

Defect	Appearance	Cause	Prevention
Abrasion marks or streaks.	Surface of paper abraded or scratched; results in fine dark lines on the surface of the print, especially with glossy paper.	Friction or rubbing on the surface of the paper.	Store paper boxes on their edges; handle carefully; make sure that processing solutions are free from grit or undissolved particles. Inspect and clean rollers of processing machine.
Bad definition in parts of print.	Parts of print poorly defined, blurred, as if out of focus, though negative is sharp.	Buckling of paper in the contact printer, thereby blurring these parts.	Check contact pad in printer. Pressure springs should be firm and strong.
Bad definition over entire print.	Completely blurred print from sharp negative.	In contact prints, because of printing from the wrong side of the negative. In enlargements, careless focusing or, more often, vibration of the enlarger, especially at high magnification.	In contact printing,the paper emulsion must always be in contact with the emulsion of the negative. Enlargers should be braced firmly and protected from vibration
Round white (light) spots on print.	Round white or light spots in picture area.	Air bells prevent developer from working on parts of paper.	Proper agitation of print in developer.
Round dark spots on prints.	Round or circular-shaped dark spots.	Air bells on surface of print in fixing bath allows developer to continue to work	Use a stop bath between developer and fixer. Agitate thoroughly in fixing bath.
Round discolored spots appearing some time after drying.	Round discolored spots in picture area of print.	Air bells in washing prevent removal of hypo in these areas	Thorough washing with constant agitation.
Small, well-defined brown spots.	Brown spots on front or back of print.	Particles of rust in wash water from rusty wash tanks or water pipes and/or particles of chemical dust.	Where quantities of rust are present, use a water filter in the line.

Table 11-3.–Print Defects–Continued

Defect	Appearance	Cause	Prevention
Tone of image unsatisfactory.	Greenish or muddy tone.	Overexposed then underdeveloped	Correctly exposed and developed.
Excessive contrast.	Contrasty print.	Wrong printing filter used.	Use a lower number filter.
Lacks contrast.	Flat print.	Wrong printing filter used.	Use a higher number filter
Fading	Fading or tarnishing.	Incomplcte fixing and/or washing.	Give adequate fixation and washing

CHAPTER 12

COLOR PRINTING

The mechanics of color printing are similar to black-and-white printing. Once you have mastered the techniques of black-and-white printing, you will have a solid foundation to build your knowledge and skills in color printing. The most difficult task in color printing is distinguishing between various and sometimes subtle colors and selecting filters to produce a color balanced print. That is not as difficult as it may sound. Through time and practice, you will make excellent color prints; however, before color printing is discussed, the principles of color photography and how they apply to color printing will be reviewed.

PRINCIPLES OF COLOR PHOTOGRAPHY

Most people see in color and expect their photographs to be in color. Because of customer demands and the cost benefits involved, color photography has nearly replaced black-and-white photography in Navy imaging facilities. Few amateur photographers understand the complexity of color reproduction in color photography. Most of these amateurs take their unprocessed film to a drug store or a 1-hour photo finisher. As a Navy Photographer's Mate, you are a professional. To produce professional quality color photographs, you must have a basic understanding of the color process.

COLOR IS LIGHT

The color you see is simply light. Where there is no light, there is no color. When you "see" a colored object, what you are actually seeing is the light reflected or emitted from that object; therefore, the light alone is what you see and not the actual object.

The color of light people are most familiar with is white. Actually, white light is made up of all the colors, although they are impossible to see directly. When you see white light reflected from a sheet of white paper, you are actually seeing an equal mixture of red, green, and blue light being reflected in equal amounts. You must realize and understand this fact before you print color.

Usually white is thought of as no color; however, it is more accurate to think of it as all colors. When one of the colors is absent, the color is not white light, but a different color-green, for example. When magenta (a bluish red color) is absent, the resulting color is green. When cyan (a greenish blue color) is absent, the color is red, and so forth.

As you read this chapter and when you color print, you may find it helpful to think of a color as white with something missing; that is,

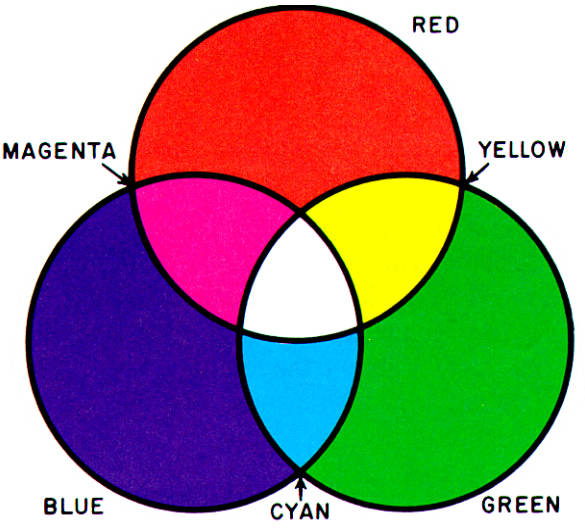
- blue is minus yellow;
- green is minus magenta;
- red is minus cyan;
- yellow is minus blue;
- magenta is minus green; and
- cyan is minus red.

Also keep in mind that

- all color is light; and
- white is all colors.

LIGHT PRIMARIES

White light is a mixture of all the colors of light; however, only three primary colors are actually needed to make white light. These three primary colors are red, green, and blue. Not only do these three light primaries produce white light, but they produce any and all other colors; for example, imagine a blue, a green, and a red spotlight shining on a white screen so the spotlight circles partly overlap. There are three places where two of the light primaries overlap and one place where all three light primaries overlap. In the areas where two primaries overlap, a distinctly new color is created



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Figure 12-1.–Mixed beams of the three primary colors of light.

(fig. 12-1). When you overlap red and green, yellow is created; green and blue, cyan is created; blue and red, magenta is created. In the area where all three light primaries overlap, you, of course, have white.

In the actual production of color prints, you should remember that

- yellow is greenish red;
- cyan is greenish blue; and
- magenta is bluish red.

The above information should help you remember the colors of light that make up yellow, cyan, and magenta, which are the light secondaries. Light secondaries are the colors produced when two light primaries are mixed.

Additive Primaries

Now that you have an understanding of light primaries, they will be called the additive primaries. The name *additive primaries* indicates that certain colors of light can be added together to create distinctly new colors.

As explained in chapter 2, color films and papers have three separate emulsion layers that are sensitive to red, green, and blue light. Because the emulsions are sensitive to the additive primaries, they can record all colors. In the three emulsion layers, three separate, superimposed images are formed and when viewed together, they give a full range of colors.

The color formation, however, is not direct; for example, in a color print, a cyan image is formed in the top or red sensitive emulsion layer, a magenta image in the middle or green sensitive layer, and a yellow image in the bottom or blue sensitive layer. These three colors or dyes-cyan, magenta, and yellow-are what produce the colors we see when we view a color print. These colors-cyan, magenta, and yellow-are called the **subtractive primaries.**

Subtractive Primaries

Keep in mind that the **additive primaries**-red, green, and blue-are the basic starting colors from which all other colors of light can be created. When you are working with light, the additive primaries produce all the other colors; however, they will not do this as dyes or pigments; for example, blue and green dyes cannot be mixed to produce cyan, though blue and green light can.

For dyes and pigments, another set of primaries are needed. This other set of primaries happens to be yellow, cyan, and magenta. Dye couplers are what form the colors within a color print (or film). The dye primaries-cyan, magenta, and yellow-can be used separately or superimposed (mixed), one image over the other, to produce other colors; that is,

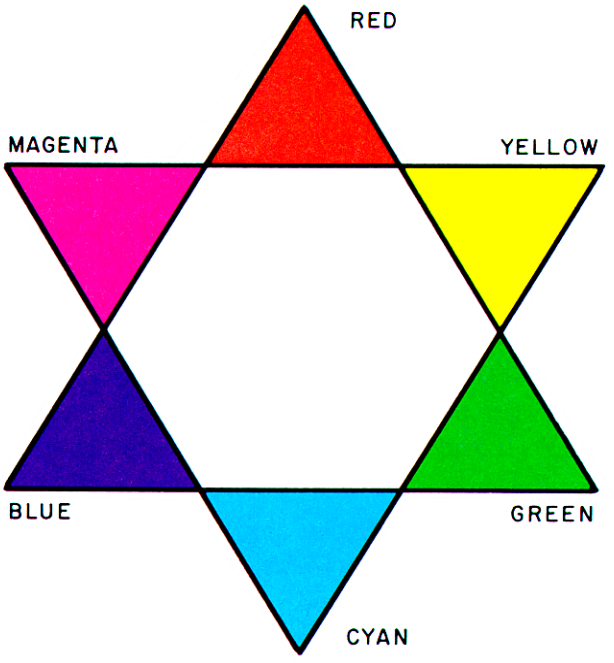
- cyan + magenta = blue;
- magenta + yellow = red; and
- yellow + cyan = green.

The colorant primaries-cyan, magenta, and yellow-are called the subtractive primaries because they subtract certain colors from the light falling on them.

Anything that is colored is subtracting something from white light; that is, an object appears a certain color because it is subtracting or absorbing a certain other color or colors from the light falling upon it; for example, an object that appears

- red subtracts green and blue (cyan) light;
- green subtracts red and blue (magenta) light;
- blue subtracts green and red (yellow) light;
- magenta subtracts green light;
- cyan subtracts red light; and
- yellow subtracts blue light.

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Figure 12-2.–Color star.

This whole concept of color by subtraction may seem confusing at first, but if you accept this concept, it will suddenly become very clear. Color printing is built around color by subtraction.

COLOR STAR

To help understand color theory, draw a color star and use it through the color process (fig. 12-2). With a color star, both additive and subtractive color effects can be illustrated.

The color star shows how colors can be mixed. Any two primaries (colors) on opposing points of a given triangle, when mixed, will produce the color between them; for example,

- green and red = yellow;
- yellow and cyan = green; and
- green and blue = cyan.

Just as important, the color star shows the colors that will neutralize each other. These colors are called complementary colors and are located across from each other; that is

- yellow is complementary to blue;
- magenta is complementary to green; and
- cyan is complementary to red.

Thus yellow neutralizes blue, blue neutralizes yellow, red neutralizes cyan, cyan neutralizes red, and so forth.

When colors are neutralized, the results are grays or blacks. That is called neutral density. The neutral density may be either full or partial, depending on the relative strengths and amounts of the neutralizing colors; for example, equal amounts of blue and yellow produce neutral density. A weak blue and a strong yellow yields a grayish yellow.

The information on the color star can be applied directly to color printing and color filtration. The filters used in color printing subtract colors from the light source of the enlarger before it reaches the color printing paper; for example, to subtract green from the light, you use a magenta filter, or to subtract blue, you use a yellow filter or vice versa.

In color printing, filters are always used to subtract a particular color. You can determine which filter subtracts a given color from the light source of the enlarger by finding its opposite or complementary color on the color star. For example, you want to subtract green from the light. First, find green on the color star. Next, locate the complementary color of green by looking across from it. You have located the color, magenta; therefore, to remove green from the light source, you must addmagenta filtration in the enlarger.

The basic overview of the principles of color photography applies directly to color printing. If you need additional review of light and color principles, refer to chapter 1 of this training manual. The remainder of this chapter should help you get a better understanding of color printing and provide the information you need to make good, professional quality color prints.

COLOR ENLARGERS AND PRINTERS

Other than the basic exposure factors of intensity and time, there are other factors to consider in printing equipment. Some of these considerations are as follows:

- Quality of the lens
- Color temperature of the light source used for printing
- Corrective filters
- Accuracy of the enlarger timer
- Stability of the power (voltage) supply

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- Ease of operation in total darkness

A good quality enlarger is required to produce high-quality color prints. Color enlargers used in Navy imaging facilities are diffusion type of enlargers. Like all image-forming equipment, the lens is an integral part of the enlarging system. The lens used in a color enlarger must be free of chromatic aberration; that is, it must be a color-corrected lens.

COLOR TEMPERATURE

The color temperature of light used to expose the color material must match the spectral sensitivity of the color material. This is true when making the original camera exposure, and it is also true when you are printing color materials. In color printing equipment, color temperature is usually regulated by adding filters to balance the light source and by regulating the voltage source supplying the lamp.

Corrective Filters

In color printing, three emulsion layers in the printing material must be correctly exposed from the three color images in the negative. The exposure of these three layers is manipulated by both exposure time and the color quality of the exposing light reaching the paper. The color or quality of light is altered by placing color filters in the light beam of the enlarger. You can use color printing (CP), color compensating (CC), or dichroic filters. CP and dichroic filters are placed between the light source and the negative. Generally, dichroic filters have replaced CP filters. Dichroic filters more accurately control the light, and unlike gelatin filters, do not fade over time. CC filters are placed between the lens and the light-sensitive paper.

The filters that control the exposing light are called the filter pack The basic filter pack differs among each characteristic of color negative film; that is, film size, manufacturer, film type, and film speed. For example, the basic filter pack for 35mm Kodak Vericolor III differs from the basic filter pack of 120 Kodak Vericolor III. The basic filter pack for 35mm Scotchcolor differs from the basic filter pack of 35mm Fuji color. The basic filter pack for Kodacolor Gold differs from Kodak Vericolor III. The basic filter pack for Kodacolor 100 differs from the basic filter pack of Kodacolor 400.

In addition to CP, CC, and dichroic filters, a CP2B or equivalent filter is usually built into the enlarger to absorb ultraviolet radiation emitted by the light source.

Voltage Regulation

Fluctuations in line voltage are more common than most people realize. Power fluctuations affect both the intensity and color quality of a light source. As little as a 5-volt variation in the normal operating range (l00-125volts) can change the output of a lamp by about 15 percent. This change in voltage results in a change in the color quality of the light source. This variation is about the equivalent of a CC10 filter.

To prevent voltage fluctuations, you must connect the enlarger to a voltage regulator. Most voltage regulators provide a constant voltage between 95 to 120 volts.

Two main types of color enlargers are in common use by the Navy. The two color enlargers differ in the way they control the exposing light. They are the subtractive and additive printers.

SUBTRACTIVE PRINTERS

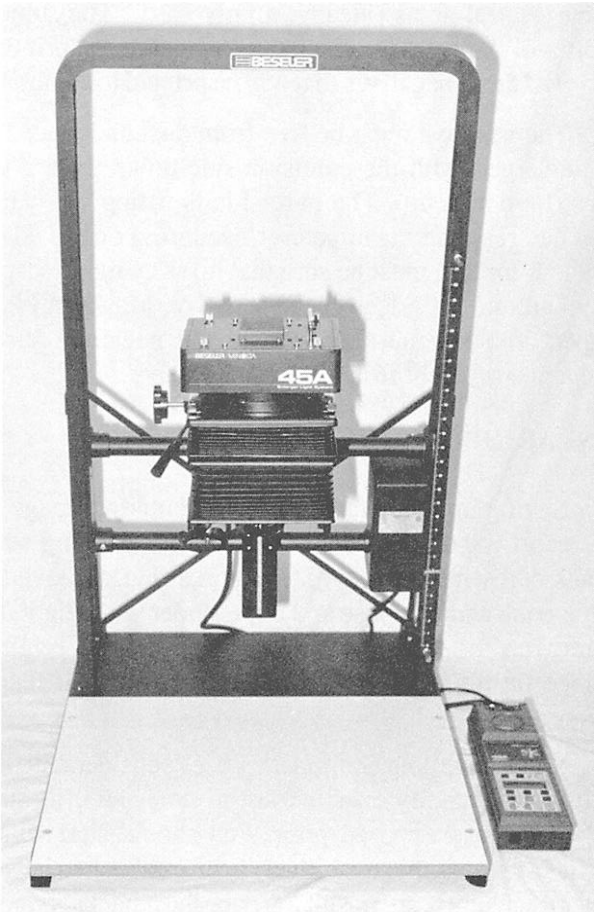
The subtractive type of color enlarger uses a dial-in dichroic filtration system. This type of color enlarger has three filtration controls that move yellow, cyan, and magenta filters into the path of the exposing light. Segments of the dichroic filters are moved in and out of the exposing light beam on calibrated cams. This type of filtration system provides accurate and repeatable filter pack combinations.

Most color enlargers use a tungsten-halogen light source. These light sources produce a great amount of heat. When a tungsten-halogen light source is used, the color printer must have forced-air cooling fans in addition to the heat-absorbing glass. An ultraviolet absorber, such as a Kodak Wratten Filter No. 2B (CP2B), must always be included in the light beam, preferably above the negative. The most common type of subtractive printer used in the Navy is the Chromega D dichroic enlarger.

NOTE: Never touch a tungsten-halogen bulb. Handle it only by the edges or reflector cone. Oil from your fingers can heat up and create a hot spot on the light bulb, causing it to burn out. If you touch the bulb, clean it with a soft cloth and isopropyl alcohol. Allow the bulb to dry thoroughly before energizing.

ADDITIVE PRINTERS

The additive type of color enlarger uses the additive or primary colors of light (red, green, and blue) to expose color printing paper. This type of enlarger uses



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Figure 12-3.–Bessler Model 45A color enlarger.

filters either above the negative (CP filters) or below the lens (CC filters) to control the color quality of the exposing light.

Bessler color enlargers (fig. 12-3) are used in many Navy imaging facilities. The Bessler Model 45A uses pulsed-xenon tubes to expose the color printing paper. The xenon tubes are mounted at the top of the head of the enlarger above red, green, and blue filters. The amount of red, green, and blue light is controlled by the number of flashes through each color filter. By adjusting the number or length of time that the filtered-light sources flash, you can correct the color balance of the print. The color head of the enlarger is normally programmed to a color analyzer that is used to provide acceptable color prints.

PRINTING COLOR NEGATIVES

For many years color printing was difficult to achieve; however, through technical advances in light-sensitive materials, chemicals, and printing equipment, color printing is as flexible and practical as black-and-white printing. The primary interest to you, as a Navy Photographer's Mate, is to produce color prints with an acceptable color reproduction of the original scene.

Good color prints are not difficult to make. Anyone who has normal color vision and can apply the principles of color theory can quickly learn to make good color prints.

NEGATIVE TO POSITIVE PROCESS

Like all negative materials, the images recorded on color negative films are completely reversed from the original scene as follows:

- Darker hues are recorded as lighter hues;
- Red is recorded as cyan;
- Green is recorded as magenta; and
- Blue is recorded as yellow.

To record the image as it appeared in the original scene, you must print the color negative onto a second tripack material-the color printing paper. If you need to refresh your memory on the characteristics of color printing paper, refer to chapter 2.

The theory of color printing is simple when you think through the stages of color reproduction. Since the colors reproduced in the color negative are complementary to the original subject colors, a red car is cyan in the negative. Cyan is a combination of blue and green; therefore, the two emulsion layers in the paper that are sensitive to blue and green are affected when the negative is printed. Then during print processing, yellow dye forms in the exposed portion of the blue sensitive layer of the paper, and magenta dye forms in the exposed portion of the green sensitive layer of the paper. Yellow and magenta in combination produce red; therefore, the red car is reproduced in its original color. All the other colors form in the same way.

CUSTOM COLOR PRINTING

In black-and-white printing, the controlling variables are primarily density and contrast. In color printing, the variables include density and the color of individual objects in the scene as well as the overall color balance of the print. The mood of a color print can be changed by altering the color balance. A winter landscape may be printed on the blue side to intensify

the feeling of coldness. Portraits, on the other hand, are usually warm with glowing flesh tones, reflecting health and happiness. Because of tightly controlled and standardized processing of color negatives, contrast is not a major variable in color printing. There are several color papers manufactured that provide higher than normal contrast. Generally, these high contrast papers are used for illustrative purposes and not normal pictorial photography. Consult the *Photo-Lab-Index* for more information on color papers.

It is unlikely that you will produce an acceptable color print on your first attempt. When you are considering the density and color balance of a test print, think in terms of the three dye layers and their individual exposures. When the paper is exposed through the color negative, the cyan, magenta, and yellow dye images control the amounts of red, green, and blue light that reach the emulsion layers of the paper. Increasing the exposure of the emulsion layers of the paper increases the dye density of that layer and vice versa.

It is helpful to think how the color quality of light affects the paper. Remember that the color negative and the color paper produce negative images. The more red light the paper receives, the more cyan dye produced. The more green light the paper receives, the more magenta dye is produced in the green sensitive layer. The more blue light the paper receives, the more yellow dyes created in the paper.

Color paper is balanced in manufacturing so a combination of magenta and yellow filters in the printer light source color balances a print from properly exposed negatives. Because of the variations in the color temperature of light sources (both picture taking and printer), processing, and light-sensitive emulsions, the required combination of filters can change from negative to negative. You must evaluate the test print in terms of density and color balance and determine which filter combination and exposure time accurately represents the original scene.

MAKING COLOR PRINTS

The procedures for setting up the enlarger and composing and cropping the image in color printing are basically the same as black-and-white printing. The major difference is that custom color printing on an enlarger must be carried out in complete darkness.

THE COLOR NEGATIVE

When making your first test print, you should use a negative that is properly exposed; it should also contain some neutral areas (ideally, a gray card). The subject matter of the negative should be typical of the printing job or of those negatives that will be printed in the future.

The negative must be free from dust and placed in the enlarger, with the emulsion side down toward the lens (base side up). The base side is facing you when you can read the manufacturer's lettering on the edges of the film. You must be sure that no stray light escapes from around the edges of the negative. Masks of black paper or black masking tape in the negative carrier prevent stray light from fogging the paper.

ENLARGER SETUP

Setting up the enlarger and cropping the image on the easel is basically the same in color printing as in black and white; however, when possible, remove the filter pack and compose and focus under white light. By removing the filter pack, you can project a brighter image on the easel, making composing and focusing easier.

Since enlarging equipment varies considerably, it is difficult to specify exact exposure times and filtration for a properly exposed print. You should start with a basic filter pack that has already been established in your imaging facility, or consult the data sheet packaged with the color printing paper or use the *Photo-Lab-Index* as a reference to arrive at a starting exposure time and filter pack

JUDGING TEST PRINTS

When making color prints, you must always obtain the proper print density before you evaluate the color balance. Several ways are used to judge test prints. Before test prints are viewed, however, there are some lighting factors to be considered.

Viewing Conditions

The color quality of the viewing light source strongly influences the apparent color balance of the print. Ideally, the light in the evaluation area should be the same color quality and intensity as the light under which the final print is to be viewed. From a practical standpoint, some average conditions are used.

Several factors are important in specifying light sources for viewing color prints. These are intensity, color temperature, and color rendering index. The intensity of the light source influences the amount of detail that can be seen in a print. For good viewing, a light source should provide an illuminance of 1400 lux

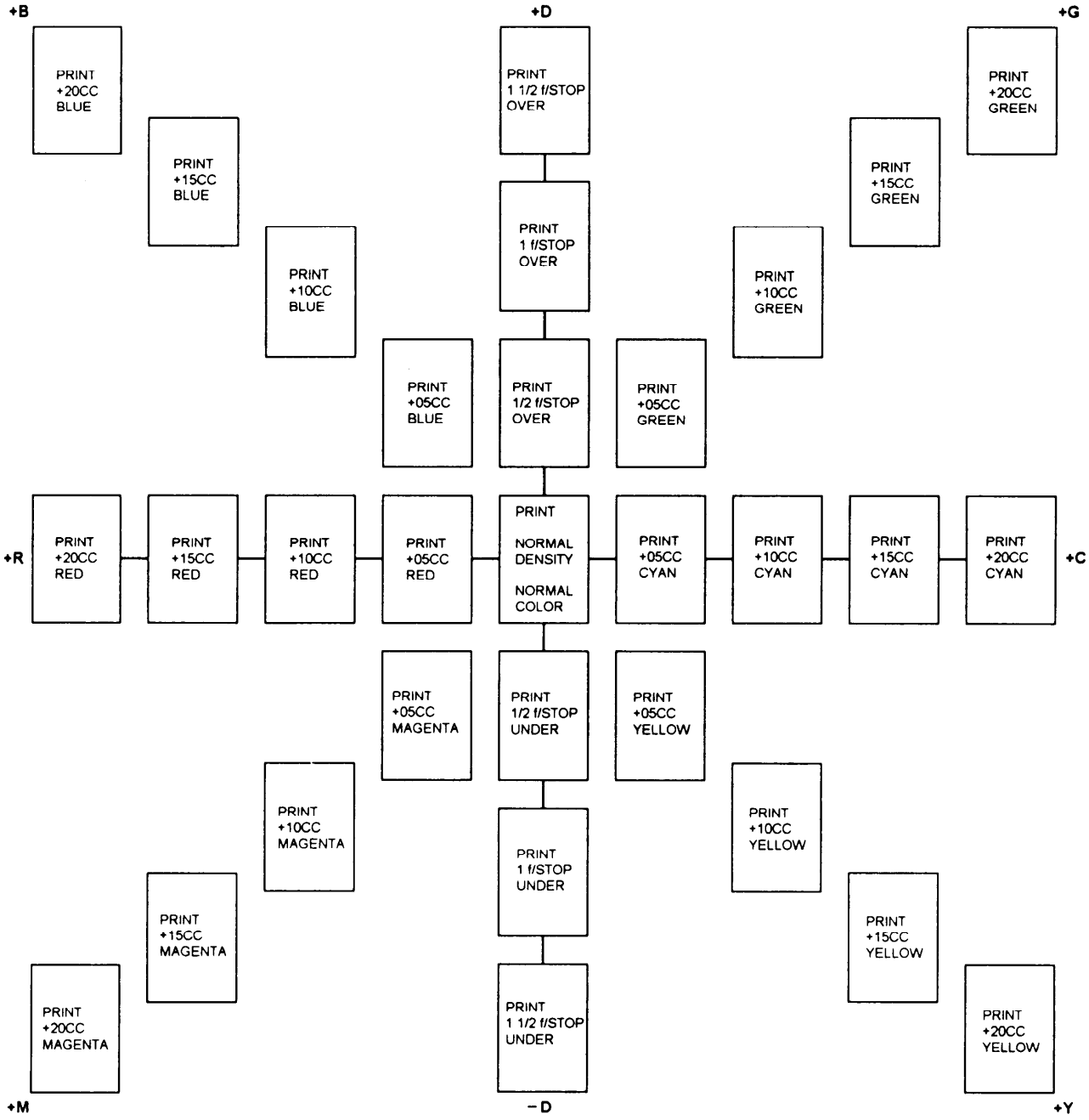


Figure 12-4.–Ring around.

±590 lux (130 footcandles ±55 footcandles). The color temperature of the light source should be between 3800 K and 5000 K. The most important characteristic of the light source is the color rendering index (CRI). The CRI is a scale from 0 to 100 and is used to describe the visual effect of a light source on eight standard pastel colors. For good color rendering in the prints being viewed, the CRI of the light source should be between 85 and 100.

Fluorescent tubes, such as the Westinghouse Living White or the Deluxe Cool White tubes (made by several manufacturers), have at least a CRI of 85 and a color temperature near 4000 K. Satisfactory results also can be obtained by using a mixture of incandescent and fluorescent light. For each pair of 40-watt Deluxe Cool White fluorescent tubes, a 75-watt frosted tungsten bulb should be used.

Ring Around

Comparing the test print to a series of prints that vary from a standard print (correct density and color balance) in known amounts is a simple method of determining color and density correction (fig. 12-4). Comparing your test print to a ring around is particularly

helpful when your test print is far from being correct. When using a ring around, you should match the test print as closely as possible to one of the prints. The amount and color of filtration you should add or subtract from the filter pack are the same as indicated on the ring around.

When the test print is reasonably close to being correct, you can predict the final exposure conditions accurately. Once again, remember how exposure affects the three dye layers of the paper. That will simplify the choice of selecting the correct filtration.

Color Printing Viewing Filters

When a test print is reasonably close to the desired color balance, viewing it through color printing viewing filters helps to determine what color change is needed. Color printing viewing filters come in six filter colors: red, green, blue, cyan, magenta, and yellow. Each color is represented in 10, 20, and 40 density values.

To use a filter, hold it several feet away from the print and light source. Quickly flick the filter in and out of your line of vision to see the color correction the filter makes. Since these filters tend to overcorrect the highlights and undercorrect the shadows, you should view the lighter middle tones through the filters to determine the desired color balance. Try several filters of different values and colors when evaluating a test print; for example, when the print looks "cold" to you, evaluate it through a series of red, magenta, and yellow filters to determine whether the color in excess is cyan, green, or blue. Similarly, viewing a "warm" print through cyan, green, and blue filters will determine whether the color in excess is red, magenta, or yellow.

Since the contrast of print materials is fairly high, a filter used in exposing a print tends to produce a greater change in color balance than the visual effect of viewing a print through a filter. In general, the filtration change to the filter pack should be one half of the viewing filter that makes the lighter middle tones of the test print appear correct; for example, you have determined that when viewing a test print through a 20CC green filter, the color balance looks correct; therefore, you would make a 10CC change to your filter pack

Suppose, again, that the test print is too blue; that is, not enough yellow dye was produced. The print will look best through a 10CC yellow filter. Since blue light creates yellow dyes, we must increase the amount of blue light reaching the paper by 05CC. You should do this by subtracting 05CC of yellow filtration (for subtractive printing) or subtracting 05CC of blue filtration (for additive printing). When a 20M filter is best for viewing, subtract 10CC G (additive printer) or 10M (subtractive printer) from the pack to produce the desired correction.

MODIFYING THE FILTER PACK

Remember, you must produce a test print with proper density before you change the filtration on your enlarger or printer. Before modifying the filter pack in the enlarger or printer, you must keep in mind what type of printer you are using. Modifying the filter pack for a subtractive type printer is completely opposite from the filter pack adjustment necessary on an additive printer.

Subtractive Printers or Enlargers

When you have determined what color dominates the test print, that filter or its complement must be added or subtracted from the filter pack Whenever possible, you should subtract filtration.

Table 12-1 may be useful in determining what filter adjustment should be made.

The following rough guide may also be helpful: When a slight shift in color balance is needed, use an 05 or 10 filter change; when a moderate shift is needed, use a 15 or 20 filter change; and when the shift required is too large to estimate, try a 30 filter change.

The filter pack should not contain more than two colors of the subtractive filters (yellow, magenta, or cyan). When all three colors are in the filter pack neutral density results. Neutral density only increases the exposure time required. Neutral density is eliminated by removing the filter color of least density completely and then removing the same amount of density from each of the other two colors. Thus, if you calculated the filter pack to be 30M + 20Y + 10C, you should remove 10 CCs of each color (10C + 10M + 10Y) completely for a filter pack of 20M + 10Y + OC.

When you either add or subtract filtration from the filter pack, the intensity of the light also changes. When filtration is added to the filter pack, the intensity of the light reaching the paper is less. When filtration is subtracted from the filter pack, more illumination reaches the paper. Thus you must adjust the exposure time when the filter pack is changed.

Fortunately, when dichroic filters are used, little exposure compensation is needed. When these filters are used, no correction is required when the yellow filtration is changed. Only a l-percent change to the exposure time is required for each 01 unit of magenta or cyan

Table 12-1.–Filter Pack Adjustments for Subtractive Printing

If the color in excess is:	If possible, subtract these filters:	OR Add these filters
Yellow	Magenta and Cyan (or Blue)	Yellow
Magenta	Cyan and Yellow (or Green)	Magenta
Cyan	Yellow and Magenta (or Red)	Cyan
Blue	Yellow	Magenta and Cyan (or Blue)
Green	Magenta	Cyan and Yellow (or Green)
Red	Cyan	Yellow and Magenta (or Red)

Table 12-2.–Exposure Factors for Kodak CC and CP Filters

FILTER	FACTOR	FILTER	FACTOR
05Y	1.1	05B	1.1
10Y	1.1	10B	1.3
20Y	1.1	20B	1.6
30Y	1.1	30B	2.0
40Y	1.1	40B	2.4
50Y	1.1	50B	2.9
05M	1.2	05G	1.1
10M	1.3	10G	1.2
20M	1.5	20G	1.3
30M	1.7	30G	1.4
40M	1.9	40G	1.5
50M	2.1	50G	1.7
05C	1.1	05R	1.2
10C	1.2	10R	1.3
20C	1.3	20R	1.5
30C	1.4	30R	1.7
40C	1.5	40R	1.9
50C	1.6	50R	2.2

change to the filter pack. Normally, cyan is not a consideration because it is set at zero in subtractive printing, so neutral density is not created.

With experience, exposure adjustments can be estimated accurately when the test print is close to the desired density and color balance. Table 12-2 provides more detailed information on exposure compensations when CC or CP filter changes are made.

To use table 12-2, you must first divide the old exposure time by the factor for any filter removed from the pack Then multiply the resulting time by the factor for any filter added. When two or more color filters are changed from the filter pack, multiply the individual factors together and use the product.

Additive Printers or Enlargers

Additive printers operate completely opposite from subtractive printers. Color correcting may get confusing if you are operating both types of printers.

When making corrections to your filter pack on an additive printer, you should make the corrections as you

see them; for example, when your test print has too much green, you "tell" the printer to subtract green from the filter pack When your test print has too much magenta, you "tell" the printer to add green to the filter pack, and so on.

The principles of color in theory are the same in subtractive and additive printing. The difference is that the additive printer uses the primary colors of red, green, and blue. When you make corrections on an additive printer, the printer is actually controlling the time that the additive colors are allowed to expose the paper through either pulsed-xenon tubes or CC filters; for example, when your test print has too much green and you subtract green from your filter pack, the printer is actually allowing more green light to reach the paper, which produces more magenta dye in processing. When the test print has too much magenta and you add green to your filter pack, the printer is actually reducing the amount of green light allowed to reach the paper, which reduces the amount of magenta dyes produced in processing.

Most additive printers automatically compensate and change the density when the filtration is changed; however, as in subtractive printing, you must achieve the correct density before making color corrections.

COLOR PROOF SHEETS

Once the basic filter pack is determined for a typical negative, the same exposure conditions can be used on future prints, providing the same types of film and paper are used. A proof sheet can provide a convenient aid in printing color negatives. The same technique used for making black-and-white proof sheets on an enlarger is used for making color proof sheets. Except when you are making color proof sheets, the enlarger height and lens-to-easel distance should be kept constant. When you are making an 8x10 enlargement from each negative, the same enlarger height that produces an 8x10 print should be used. When you must change the enlarger height from the negative previously printed, adjust the lens opening to compensate for the difference in illumination.

Assuming the exposure level for the contact prints is correct, exposures will be about the same when the negatives are placed in the negative carrier and enlarged. Some minor adjustments may be needed, however, to provide the highest quality print possible. Navy imaging facilities strive for a color balance within 05CC- because the "perfect" color print is very subjective. In most color prints, a slight color to the "warm" side is more acceptable than color prints with a slight color cast to the "cold" side. This is particularly true when the subject in the photograph involves people.

Incidentally, you should not discard the test prints. Instead, write on them the actual exposure conditions and your predicted changes to the test print. These records will help you to gain the greatest practical value from past work and to develop the judgment needed for easier color printing in the future.

THE STANDARD NEGATIVE

Briefly defined, a standard negative is an average color negative that has been properly exposed and processed and makes an excellent print. In other words, it has been printed previously, and an accurate record of the filter pack required and other printer settings for a particular type of paper is available. A standard negative is used as a reference for comparison purposes. The standard negative is useful in several ways:

- Comparing the printing characteristics with those of other color negatives
- Comparing different paper emulsions
- Checking processing
- Programming color analyzers and automated printers

The standard negative is typical of the majority of negatives to be printed. When most of your negatives are outdoor shots on Kodak Gold 35mm film, the standard negative should obviously be an outdoor shot on Kodak Gold 35mm film. The standard negative must be normally exposed, normally processed through your imaging facility, and a typical subject with typical lighting; that is, the lighting ratio and light direction should be similar to most of your production negatives.

A gray card included in the image area of a standard negative is extremely helpful. The gray card can be used to determine whether the negative received the correct exposure; for example, a Kodak Vericolor III negative is properly exposed when the gray card density in the negative is between 0.65 and 0.85 when read through a red filter on the densitometer. For other types of film, consult the *Photo-Lab-index* to locate the proper density measurements. When used in a standard negative, the gray card must receive the same exposure as the subject.

One good practice is to have a standard negative for each general category of photographic assignments produced by your imaging facility. These standard negatives should be produced with the equipment,

light-sensitive materials, and lighting conditions commonly used in your facility; for example, when awards presentations are commonly photographed using syncro-sun techniques with a medium-format camera and Kodak VPS film, then your standard negative should be taken under the same conditions. The same applies for studio portraits, indoor on-camera flash photography, and so forth. A basic enlarger filter pack should be determined for each negative.

TRIAL-AND-ERROR PRINTING

Few characteristics are exactly the same in two color negatives. Even when the subject matter is similar, differences can be caused by normal manufacturing variations from one emulsion to another, adverse conditions before exposure, illumination of different color quality, variance in sensitivity with changes in illumination level and exposure time (reciprocity effect), adverse storage conditions between exposure and processing (latent image loss), and nonstandard processing conditions.

Most color negatives of the same subject that are exposed under similar conditions print similarly, but not identically. Differences may result from variations in lighting conditions (time of day, sky conditions, etc.), film emulsions, film processing, or other factors. These differences are normal and should be expected. The standard negative provides a good starting point for future printing requirements.

For example, you made an excellent 8x10 print from the standard negative with a filter pack of 40M + 60Y and exposed the print for 10 seconds at f/5.6. The enlarger settings should remain the same as a starting point for similar negatives, providing the same type of paper is used. For a particular production negative, you may find it necessary to add a 10M filter to the pack and adjust the printing time to 11 seconds to compensate for the differences between the new negative and the standard negative. In other words, the new negative may print differently from the standard negative by a 10M filter and a 10-percent increase in printing time.

The amount and types of color equipment you use depend on the volume of color production of the imaging facility where you work. A photo lab that makes occasional color prints probably uses only a standard negative and color printing viewing filters. Larger Navy imaging facilities that produce large quantities of custom color printing may use evaluation methods involving instruments, such as color analyzers, densitometers, and other electronic devices.

COLOR ANALYZERS

Color analyzers operate by comparing a standard negative to production negatives. For successful negative evaluation, the reference areas must have the same subject matter in all the negatives; for example, a gray card included in the picture, a flesh tone, the highlighted area of an aircraft wing, or a neutral area of a ship, all provide a suitable reference area. In portraiture, a medium-flesh tone is often selected In other fields of photography, you should either include a gray card in the scene or expose an additional negative replacing the subject with a gray card. In the latter case, the negative with the gray card is used only for evaluation purposes and is replaced by the subject negative when the print is made.

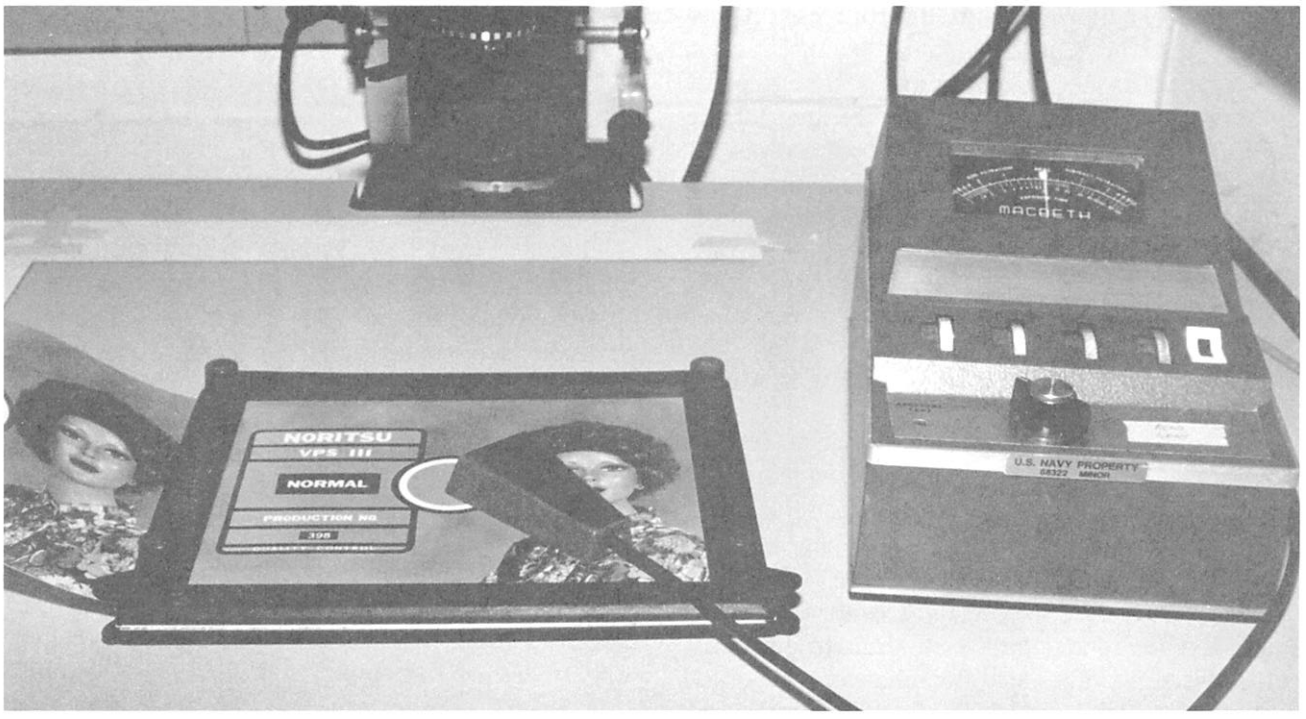
When a skin tone is used instead of a gray card in portrait negatives, the color analyzer tends to reproduce all skin tones the same as the standard negative regardless of variations in skin color or lighting. Similarly, all images of a gray card tend to be printed alike regardless of the position of the card relative to the main light.

Color analyzers are used to reduce the waste that is produced through the trial-and-error method of color printing. The standard negative is used as a reference when color analyzing instruments are used. There are two categories of color analyzers: off-easel and on-easel.

Off-Easel Analyzers

Off-easel color evaluation is performed by measuring or evaluating the color negative before it is placed in the enlarger. Commonly in Navy imaging facilities, off-easel evaluation is accomplished using a densitometer. The main advantage of using a densitometer is you can service a number of enlargers. That is especially useful when you cannot have on-easel analyzers for each color enlarger. Another advantage, off-easel evaluation can be done under normal room lighting conditions.

To set up an off-easel evaluation system, you must first read the density of the reference patch from your standard negative on a *transmission densitometer.* You read the reference patch through a red, green, and blue filter. The densitometer provides you with direct density reading of the cyan, magenta, and yellow dyes present in the reference patch. The values that you read from the reference pack are then added to the known standard negative filter pack of the enlarger. The production



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Figure 12-5.–On-easel color analyzer.

negative to be printed is then read on the densitometer and these densities are subtracted from the total density values of the standard negative (negative reference patch and enlarger filter pack). This method of evaluation does not indicate directly the required exposure for the production print, but the production print exposure can be estimated closely by using the standard negative exposure and compensating for any changes to the filter pack. An example on how this off-easel evaluation system operates is as follows:

Gray patch of standard negative	=	47C 51M 50Y
Established filter pack for standard negative	=	0C 47M 34Y
Sum:		47C 98M 84Y
Subtract gray patch of production negative		–44C 63M 49Y
Difference:		03R 35G 35Y
To illuminate neutral density		– 03 03 03
Production negative filter pack		0C 32M 33Y

A reflection densitometer also can be very useful in color print evaluation. A reflection densitometer can be used to match an earlier printed print with the color print you are currently printing. To use a reflection densitometer as an aid in color printing, you must compare or read a reference area on your test print. This is particularly useful when you are making a color print with neutral areas. As you know, black, gray, and white have approximately equal portions of red, green, and blue. By taking a reflection densitometer reading directly from one of these neutral areas (such as a gray card, the side of a ship, or part of a gray aircraft), you can determine what color and the amount of that color in excess. To change your filter pack for print corrections, you must take one half of the density value as read from the densitometer and either add or subtract that value from your filter pack; for example, you take a reflection densitometer reading from a gray patch on your color test print. Your density readings are 50R, 50G, and 70B. The densitometer indicates that your test print is high by 20B (too much yellow dye). To adjust the filter pack, you should add CC10Y to your filter pack for subtractive printing or add CC10B on an additive printer.

Another off-easel color evaluation system is a *color video analyzer.* This system scans the color negative and is viewed directly on a color monitor. The image on the monitor can be manipulated until the proper color balance, density, and image size are achieved. The

corrections are then sent through a translator device to the printer. This system has essentially been replaced with electronic darkrooms at Navy imaging facilities.

On-Easel Analyzers

An on-easel color analyzer (fig. 12-5) is an electronic photometer used to measure the illumination and three color primaries of light on the baseboard of the enlarger. These photometers take these measurements through tricolor filters.

On-easel measurements are made conveniently by placing a small probe on the reference area of the projected image on the baseboard. This small probe is connected to a fiber-optic light tube that carries the light from the reference area to the body of the photometer.

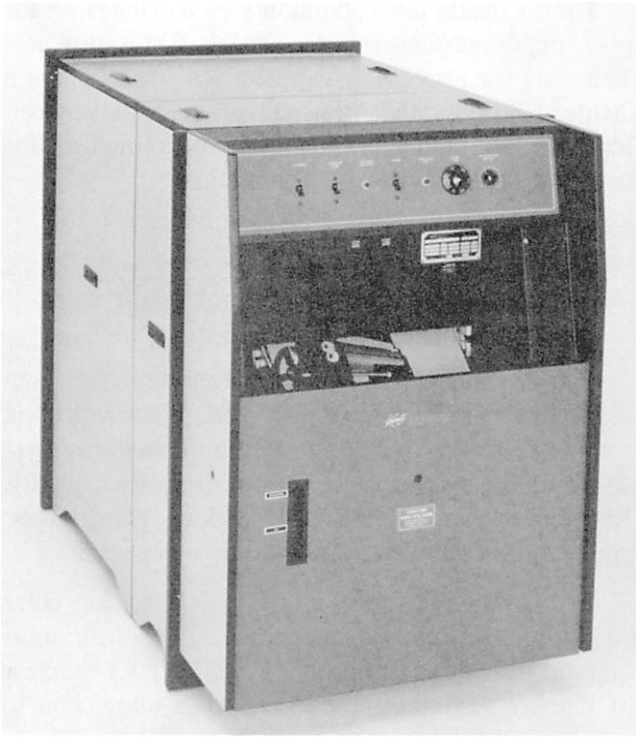
Color analyzers are programmed using standard negatives printed by the trial-and-error method of color printing. Once a good color print is made from the standard negative, the image luminance of the master negative is measured from the reference area. This reference area is read through red, green, and blue tricolor filtered sensors and finally without filters over the photocell. The analyzer scale is then zeroed for each condition. You then insert the new production negative in the enlarger and place the photocell on the same projected reference area on the easel. The aperture and dichroic filters are then changed until the meter is zeroed out once again.

Most on-easel color analyzers have a number of memory channels so you can store programs for different film or paper types.

The advantage of on-easel color analyzers is that, unlike off-easel evaluation, each measurement compensates for filter fading, lamp aging, and different image magnifications. Exposure and filtration are given directly. A disadvantage is that the readings must be made under the same conditions as color printing on an enlarger (complete darkness except for the illumination of the projected image of the enlarger). Both on-easel and off-easel evaluation depend strongly on accurate readings and placement and choice of a good reference area.

Two methods of electronically aided color evaluation are used. They are spot or small-area measurements and large-area or integrated measurements. Small-area measurements made on the easel are the most accurate; however, a small-reference area is not always possible.

When small-reference areas are not provided, large-area measurements can be taken. Large-area measurements are made usually from the whole negative area. For off-easel evaluation using a densitometer, a large photocell is used to take such readings. For on-easel analyzers, the image is integrated by placing diffusion material between the negative and the photocell. You then place the photocell and sample various areas of the projected image. These sample areas are then "'integrated" to gray as though they were a typical subject. This type of evaluation does not compensate for images that do not contain typical color or tonal distributions; for example, when the subject of a negative is predominantly red, an integrated reading overcompensates and a cyan print results. That is called *subject anomaly* or *subject failure.* This is the method used by many automatic printers. Color prints, such as these, must be color corrected manually.



Courtesy of Kreonite Inc.
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Figure 12-6.–Kreonite color processor, Model KCP-16.

COLOR PRINT PROCESSING

Color printing paper must be handled and processed in complete darkness because color paper is panchromatic. Like color film, time and solution temperature is much more critical than in black-and-white processing. Because the processing of color paper must be very consistent, color prints are not processed in trays. Color paper is always processed in automatic color print processors (fig. 12-6) or rotary drum processors.

The chemistry most commonly used in the Navy for color paper processing is Kodak Ektacolor RA Chemicals for Process RA-4. The RA-4 process is a washless process that consists of color developer, bleach/fix, and stabilizer. The total processing time for the RA-4 process is about 4 1/2 minutes.

MAKING TRANSPARENCIES FROM COLOR NEGATIVES

You can make brilliant color transparencies from color negatives as easily as you made color reflection prints by using color printing materials on a transparent film base. These transparencies are of excellent quality. This allows you the option of making them larger, smaller, or the same size as the original negative.

Several materials are available for making color transparencies from color negatives. Two of the most common are Kodak Duratran RA and Kodak Duraclear RA display materials. These materials allow you to make large-display transparencies from color negatives.

The Kodak Duratran RA and the Duraclear RA transparency materials can be printed using the same methods, printing equipment, and processing chemicals as Duraflex RA print paper. Both the transparencies and paper are processed using Kodak Ektacolor RA-4 chemicals; however, the transparency materials require a longer processing time. The Kreonite Model KCP-16 allows for this longer processing time. By flipping a switch, you can slow down the processor, allowing for a longer processing time.

When printing color transparency materials, you must use a black easel. Because these materials do not have a paper backing, light is transmitted through the material and reflects back when a black easel is not used. All other printing steps are the same in printing color paper and color transparency materials. Consult the *Photo-Lab-Index* for starting exposure and filter pack settings.

COLOR PRINTS FROM COLOR TRANSPARENCIES

Color prints can be made directly from color transparencies (slides) without the time and expense of making an internegative, but the quality of a print can only be as good as the quality of the transparency from which the print is made. Originals that are poorly exposed or processed or are damaged or dusty do not provide satisfactory prints.

Transparencies that are old or stored under adverse conditions are likely to fade to some degree. This fading may not have been equal overall. That can create problems in printing. Generally, slide duplicates vary widely in quality and do not make high-quality color prints.

There are several direct positive materials available for making color prints directly from color slides. Kodak Ektachrome 22 paper is a reversal color paper that, when exposed to a slide, produces a positive color image of the slide. Kodak Ektachrome 22 paper is processed in Kodak Ektachrome R-3000 chemicals. Consult the *Photo-Lab-Index* for the most updated information concerning these processes.

Another way to make full-color prints directly from color transparencies is by the dye destruction color process. At the time this training manual was written, *Cibachrome* products are the only direct positive color materials manufactured using this process.

Cibachrome silver-dye-bleach materials consist of a white opaque support, coated with light-sensitive emulsion layers on one side and a matte, anticurl gelatin on the opposite side. This white pigmented plastic film base has a similar appearance to paper but is actually a film, much like color slide materials-the emulsion layers are arranged in the same order as color transparency (slide) materials (including the yellow filter layer).

Unlike conventional color paper processes where dyes are formed from color couplers during processing, dyes in Cibachrome materials are incorporated in the blue, green, and red light-sensitive layers during manufacturing. These cyan, magenta, and yellow dyes are designed to be destroyed when processed. Red exposure is intended to cause the destruction of cyan dyes, green exposure leads to the destruction of magenta dyes, and blue exposure sets up the destruction of yellow dyes.

The processing of Cibachrome materials involves four chemical steps: black-and-white developer, bleach, fixer, and stabilizer. In the black-and-white developer, the exposed silver halide crystals are reduced to metallic silver. When the silver halides in the emulsion layers are converted to metallic silver, the dyes present in the emulsions are fragmented. In the bleach, the silver image is converted back to silver salts (halides), and the dye fragments are made either colorless or water soluble. The unwanted silver salts (halides) are then removed in the fixer. The stabilizer keeps the remaining color dyes more permanent.

The principles of making color positive prints from color transparencies are the same whether coupler development or dye destruction materials are used. Colored filters are used to alter the printing light to obtain proper color balance, much the same as is done in printing color negatives.

You must keep in mind, however, that you are working with color positive materials, and not negative materials. The borders of these positive materials are black when unexposed. Dust particles and scratches also appear black. To make a test print lighter, you must increase the exposure. Dodging darkens selective areas of a print, and burning in lightens selective areas of a print. Color corrections are performed the same as the visual appearance requires.

AUTOMATED PRINTERS

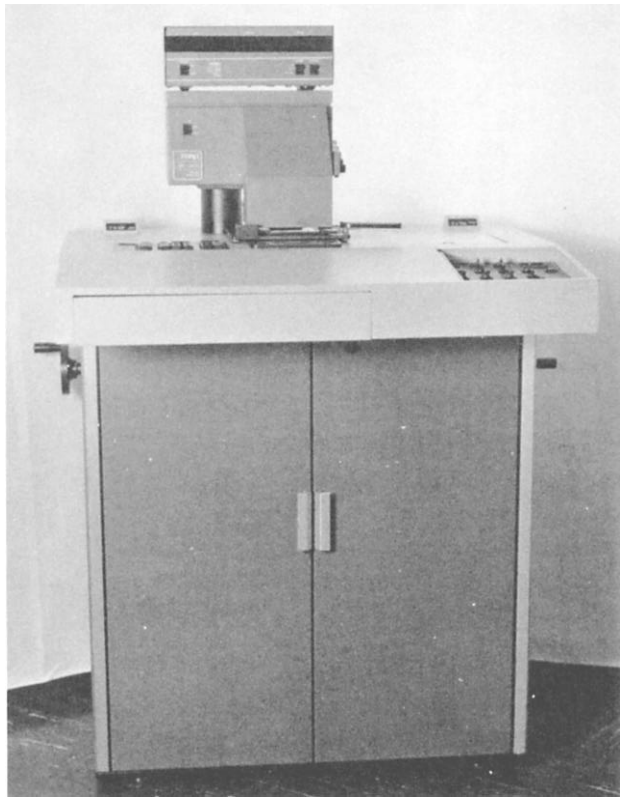
Many Navy imaging facilities have automated printers that print photographic negatives. Most can be used to print both black and white and color. When high-volume production is routine in an imaging facility, automated printers are an invaluable piece of equipment.

There are many types of automated printers throughout the fleet. Some types hold long rolls of photographic paper that must be taken out and processed through a processor. Other more sophisticated types analyze, expose, cut, process, and dry the paper automatically.

ROLL PAPER PRINTERS

The roll paper printer is very popular on larger ships and shore stations that produce a large volume of color prints. The advantages of roll paper printers are they are operated under normal room lighting conditions, and they are very useful when a large number of the same size prints are needed from a single negative. When these printers are used, the correct density and color is accomplished by making test prints. Once the corrections and number of prints required are keyed into the printer, the printer makes each exposure and advances the paper automatically. When the printing is completed, the exposed roll of paper is removed and processed. After processing, the prints are then cut from the roll with a paper cutter.

Roll paper printers have built-in analyzers. These analyzers are calibrated using standard negatives. When a production negative is printed, the machine refers to the memory and produces a print using the information stored from the standard negative. Generally, that produces a print that closely represents the original scene; however, test prints are still made to produce the highest quality prints possible. The most popular roll paper printer used in Navy imaging facilities is the Pako BC 24 (fig. 12-7A and fig. 12-7B).



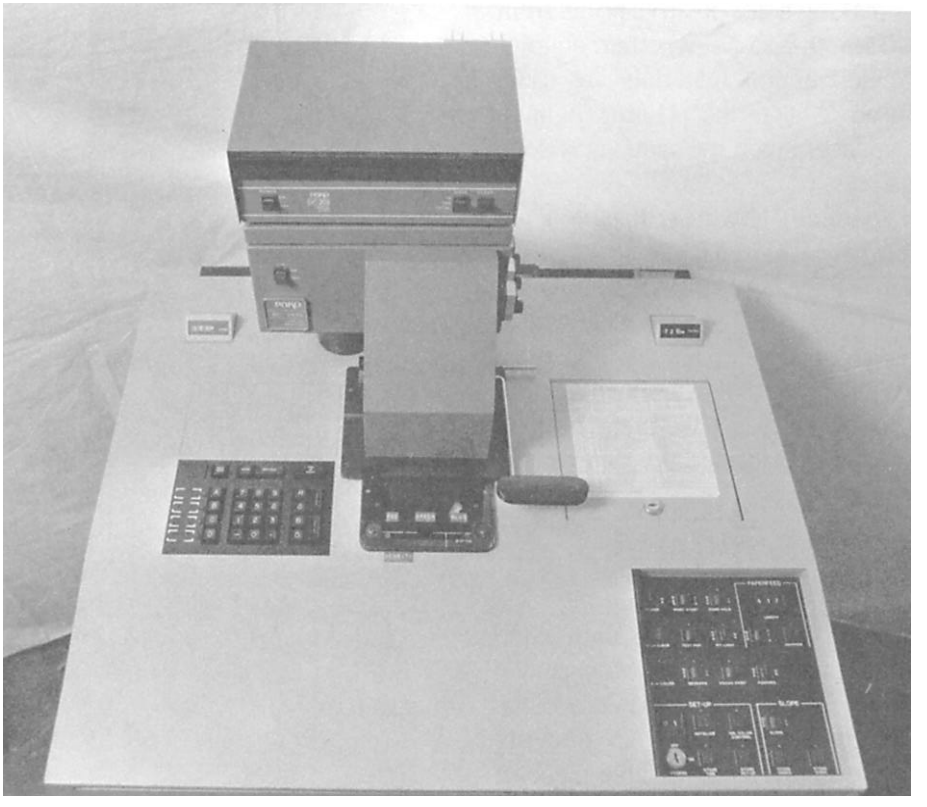
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Figure 12-7A.–Front view of Pako BC 24 roll paper printer.

MINILAB SYSTEMS

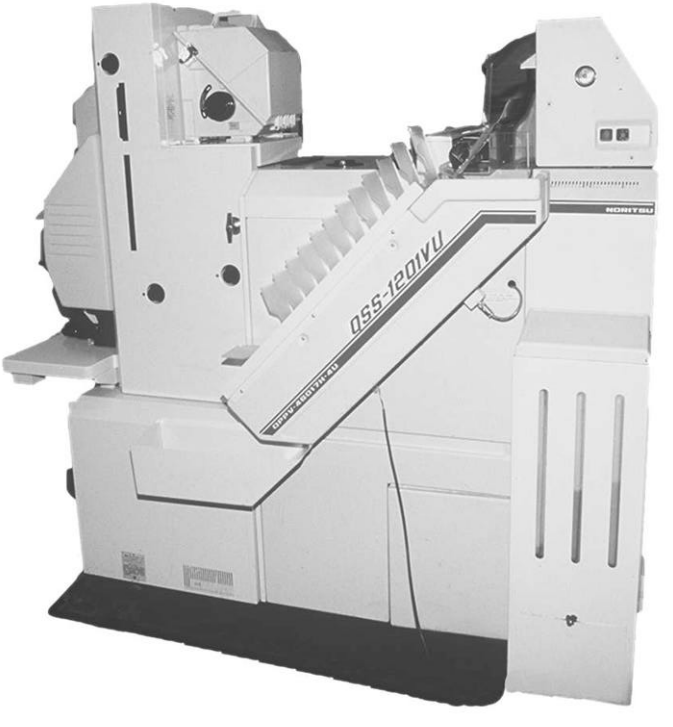
Minilab systems (fig. 12-8) have become very popular in Navy imaging shore facilities and aircraft carriers. These types of printers are fast and can be used to rush production. In these systems, the printer and processor are combined into one unit. The printer cuts the paper to size, exposes it, and automatically feeds it through the processor. Minilabs (as they are called) are used in all of the “One Hour” photo-finishing shops that you see today.

The operation of a minilab is very easy once you become familiar with the system. Minilabs can be operated under normal room lighting conditions. The printer is controlled by a keyboard (fig. 12-9). Some systems have zoom enlarging lenses to alter the image size. The negative can be aligned and composed by adjusting the negative carrier. These adjustments to the image size and cropping can be seen on a viewing screen.



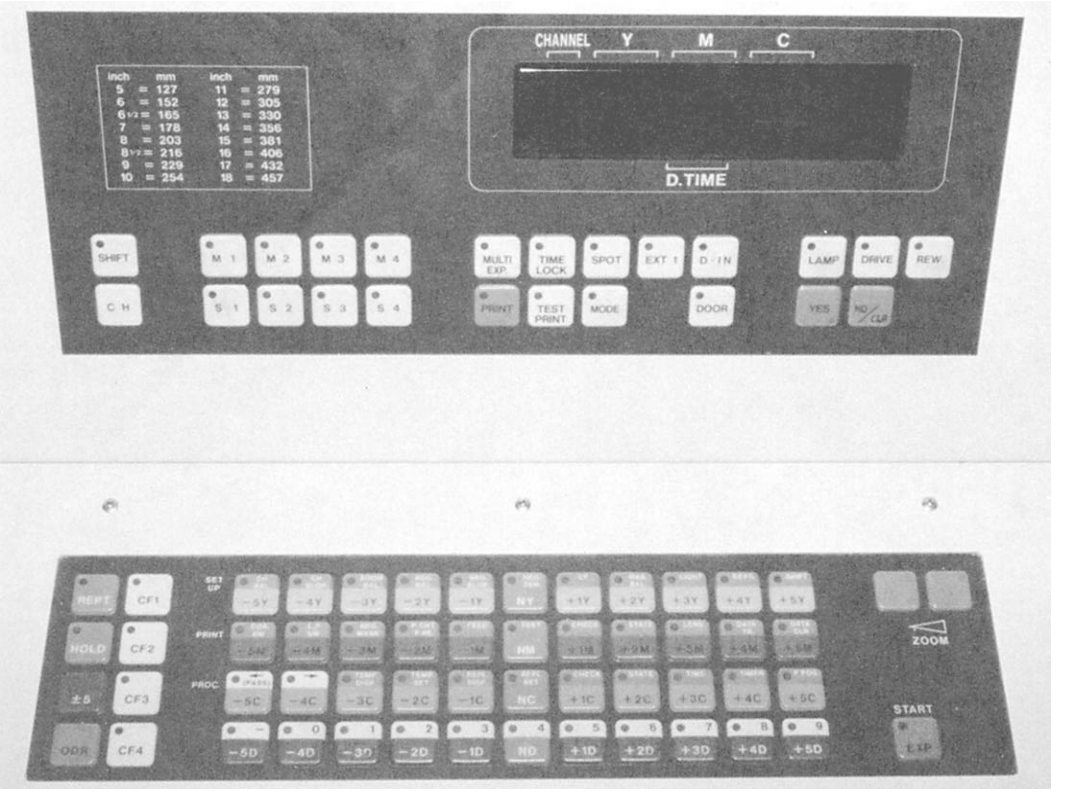
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Figure 12-7B.–Top view of Pako BC 24 roll paper printer.



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Figure 12-8.–Noritsu QSS-1201 minilab system.



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Figure 12-9.–Keyboard of a Noritsu Model 1001 print processor.

Minilabs have a microprocessor that stores information put in by a programmer. The information is retrieved through channels. The channels are programmed for different film manufacturers, ISOs, negative sizes, print sizes, and paper combinations. The various information combinations that are stored in these channels are used to print production negatives; for example, a 35mm Kodacolor negative to a 4x5 print is printed on one channel, and 35mm Fujicolor negative to a 5x7 print is printed on another. By programming different negative and print combinations into separate channels, you are able to produce production prints which have good density and color balance from the automatic printer. You can also fine-tune the density and color by using the keyboard.

Color correcting on a minilab is less complicated than on an enlarger. The keyboard of the printer contains yellow, cyan, magenta, and density keys. These keys range in value so you can make minor or major adjustments. When the density of the print is off, density can be either added or subtracted. When a production print has too much cyan, yellow, or magenta, these colors are subtracted. When the print has too much red, green, or blue, the complement of these colors is added.

After the prints are exposed, the paper is fed automatically into the processing section of the minilab. The processing section contains chemical tanks and a dryer section. Each tank has a roller assembly rack that transports the print through the processor. Minilabs require no plumbing or drains because they use a washless process, such as KodakRA-4 chemistry. When Kodak RA-4 chemistry is used, the total processing time is completed in about 4 1/2 minutes.

The setting up and programming of automated printers can be complicated. You are expected to be a printer operator only. Programming the channels, density, and color balance of automated printers should be left to the more experienced imaging facility personnel.

While automated printers are very useful in controlling a high influx of production, there are disadvantages in their use. Not all imaging facilities have the space required to support automated printers. Cropping is very restricted, and dodging and burning cannot be performed. Like all machines, automated printers require maintenance. They also must be programmed accurately to function the way they are designed. Without the support and expertise of knowledgeable personnel, normal projection printing may be preferred.

CHAPTER 13

MOTION MEDIA

Motion media has gone through many technical advances in the past several years. Portable motion-video cameras have changed from cumbersome cameras and recording packs to small hand-held cameras. Reduced size, improved quality, and easier operation has, and is continuing to improve and expand motion video in all areas of the Department of Defense. Most Navy ships have closed circuit television systems for information, entertainment, and educational purposes. Motion media is distributed easily and dominates all other sources of communication in today's society. Because of this, the Navy uses this form of communication extensively to relay information.

The most common form of motion-media photography is video. Since the motion picture is the grandfather to the technology of motion media as we know it today, it is discussed briefly in this chapter.

MOTION PICTURE

The first fact regarding motion pictures is they do not move. Each image or frame of motion picture film is a separate, still photograph. These individual images or frames are normally recorded at a rate of 24 separate pictures per second. This rate can be varied to achieve certain effects. Since so little time passes between exposing one frame and the next, there is relatively little difference between pictures, even when the subject moves rapidly.

The illusion of motion in motion-picture photography is due to the natural characteristic of human vision. This characteristic of human vision is called *persistence of vision.* Persistence of vision was discovered by Peter Mark Roget, the author of the famous Thesaurus. The retina of the eye continues to perceive an image for a short period of time after the light stimulus representing the image has been removed. Usually, this "after image" lasts about 1/50 second, depending on the brightness of the image.

In viewing a motion picture, the eye continues to perceive the fading image projected from one frame as it is replaced by the next frame, and so on. In effect, the images are momentarily superimposed in our vision, so any differences between them, however slight, are mentally noted. If these differences suggest any relative change in subject position, the apparent difference is mentally interpreted as motion. The mind translates this information into the logical deduction that whatever we are seeing on the movie screen must be moving.

CAMERAS

Since motion pictures are a series of still pictures, the motion-picture camera is basically the same as the still-picture camera. The primary difference is that it has a mechanism for taking a series of many photographs in rapid succession and at regular intervals on a ribbon of film. All cameras have the following four basic parts: a lighttight compartment, a lens or lenses, a shutter, and a film plane or pressure plate.

The motion-picture camera has two additional basic features; the film drive and intermittent action. The film drive mechanism transports the film continually from a supply spool of unexposed film to a take-up spool of exposed film. This transport takes place by means of toothed, drive sprockets. The teeth of the drive sprockets engage the perforations along the edge of the film and move the film through the camera.

The intermittent action in a motion-picture camera is caused by a pulldown claw that advanced the film one frame at a time at the film gate.

During one cycle of operation of a motion-picture camera, the following action takes place. The film is advanced by the sprocket drive mechanism. The pulldown claw or shuttle then advances the film one frame. The film is stopped momentarily and the shutter revolves once, thereby making the exposure. The pulldown claw then moves the film to the next frame for exposure. Because the film moves in an intermittent or stop-and-go manner, it becomes necessary to have a surplus or loops of film before and after the pulldown claw to help take up the

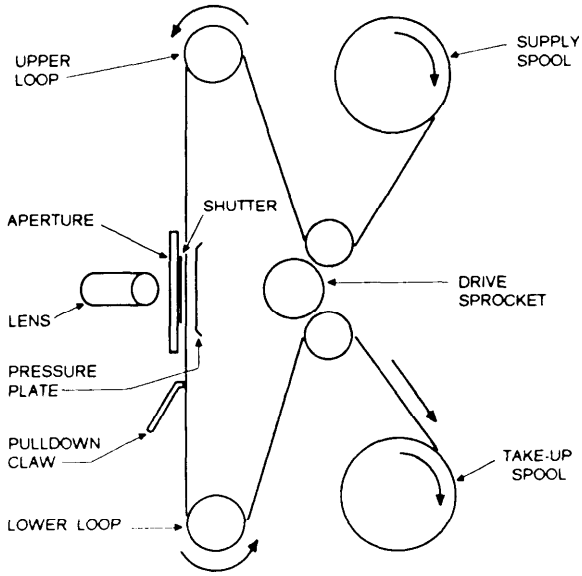


Figure 13-1.–Basic components of a motion-picture camera.

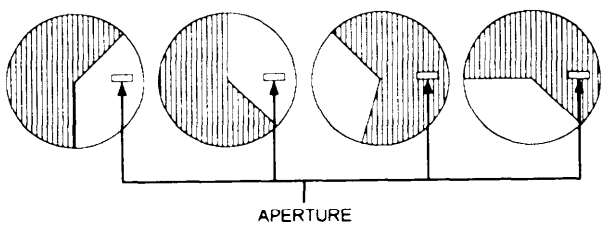


Figure 13-2.–Rotary shutter.

shock and prevent the film from breaking (fig. 13-1).

The shutter in most motion-picture cameras is a focal plane type and is called a rotary disk shutter. A rotary disk shutter is a disk that has a segment cut out, causing the shutter to have a light and dark cycle as it rotates. Exposure is made when the cutout segment of the shutter passes in front of the film. The film is advanced during the dark cycle (fig. 13-2).

A motion-picture camera is used to photograph action in a rapid succession of still pictures on a long strip of film. Each picture area on a motion-picture film is called a frame, and the speed that the camera is operated is called frames per second (fps). The standard operating speed for 16mm cameras is 24 fps. When the camera operating speed and the rate of projection are the same, the action looks normal; therefore, the standard projection speed is also 24 fps. However, it is possible, and sometimes desirable, to make motion pictures at a slower or faster rate than 24 fps. You may do this to either slow down or speed up the action on the screen. To portray a subject in slow motion, you operate the camera at a speed faster than the standard 24 fps, but keep the projector at the standard speed. To portray a subject in fast motion, you operate the camera at a speed slower than 24 fps, and the film is projected at 24 fps. All changes to the portrayal of normal subject motion should be done by adjusting the camera speed, not the movie projector.

Camera speeds in the thousands of frames per second are used in scientific and experimental research to measure and observe such things as the fall of liquids, the speed of objects in flight, and the bursting characteristics of objects. When films shot at very fast fps rates are projected at 24 fps, the illusion of subject motion on the screen is slowed down considerably. At these speeds the viewer can study details of the subject matter and obtain research data.

Motion-picture cameras are classified according to the size (width) of the film they use. The most common motion-picture film sizes are as follows: 8mm, super 8, 16mm, and 35mm. In the Navy today, motion-picture film has almost been completely replaced with video film; however, Hollywood productions still use motion-picture film as large as 70mm.

Lenses used in motion pictures are basically the same as lenses for still photography; therefore, the information on optics presented in chapter 1 also applies to motion-picture camera lenses. The standard or normal focal length lens for a 16mm camera is 1 inch (25mm). Longer or shorter focal length lenses should be considered as long focal length (telephoto) or wide-angle lenses, respectively, depending on what size film is used. A long focal length lens for 16mm film is 38mm or longer. A wide-angle focal length lens for this camera is 13mm-17mm. Table 13-1 illustrates some typical camera and lens combinations.

FILTERS

With one exception, the use of filters for motion pictures is the same as for still photography. The effects that filters produce on motion-picture film emulsions are the same as the effects they produce on still photographic film emulsions. The one exception is the use of a polarizing filter. Camera panning should be avoided because variable darkening of the image results. The information on filters presented in chapter 3 applies to motion-picture photography as well as still photography.

Figure 13-1.–Camera Sizes and Lens F-1 Lengths

	8mm	16mm	35mm
Normal	12mm	25mm	50mm
Wide Angle	6 to 9mm	13 to 17mm	35mm or less
Telephoto	25mm and above	38mm and above	100mm and above

EXPOSURE CALCULATION AND CONTROL

Exposure meters for measuring incident light can be used directly to help determine lighting ratios. A gray card is used to get an accurate exposure reading whenever reflected light meter readings are taken.

Incident light exposure meters are very useful for motion pictures because they can be used at a scene to calculate exposure before the subject arrives. They also can be carried throughout the scene, thereby indicating uneven lighting or "hot spots," thus indicating whether the lighting should be altered.

With a motion-picture camera, the final exposure adjustment is usually made only with the aperture because fps rate of the camera determines the shutter speed. The goal of exposure control for motion pictures is to produce **consistent** and **uniform** image densities and tones from one scene to the next.

Accurate and correct exposure control can be achieved only through the proper use of a good exposure meter. The exposure time for a movie camera is a result of the rate at which the camera is operated (usually 24 fps) and the shutter degree opening (the degree of the open segment of the shutter). The shutter degree opening for a particular camera is provided by the camera manufacturer. Given the shutter degree opening, you can determine exposure time by use of the following formula:

$$\frac{\textit{Shutter Degree Opening}}{360 \times \textit{fps}} = \textit{Exposure Time in Seconds}$$

For example, suppose you have a camera with a shutter degree opening of 175 degrees and you intend to be filming at the standard rate of 24 fps. Determine the shutter speed as follows:

$$\frac{\textit{Shutter Degree Opening}}{360 \times \textit{fps}} = \frac{175}{360 \times 24} = \frac{175}{8640} = \frac{1}{49}$$

or 1/50 second

NOTE: 360 is a constant factor (number of degrees in a circle).

The information on exposure provided in chapter 4 applies equally well to motion-picture photography as it does to still photography.

Neutral density filters (ND) are often used in motion-picture work to help control exposure because of the limited f/stop and shutter speed combinations available on motion-picture cameras. When you are shooting a movie, the fps and the shutter degree opening are fixed. You may not be able to open up the aperture to get the correct exposure control and depth of field; therefore, you would use an ND filter to reduce the amount of light reaching the film. Remember, because of the fps rate, you are restricted to a given shutter speed, and stopping the lens down would destroy your depth-of-field effect.

MOTION VIDEO

Videotape recording has basically replaced motion-picture film making. Motion video has a number of advantages compared to motion-picture coverage. Some of these advantages are as follows:

- A videotape camera can record black and white as well as color.
- No time-consuming film processing is required and recordings can be played back immediately.
- When necessary videotape may be partially or completely erased and used again for several more recordings. It can be played back numerous times and may be stored indefinitely.
- Videotape is edited or assembled more quickly than film.
- Videotapes are duplicated and distributed easily to other Navy activities.

A video camera is optically similar to a movie camera, except it does not use film. Considering the

technical complexity of a video camera, it is fundamentally simple. To understand clearly motion video, you must be familiar with some key terms. These terms will be seen commonly in all publications pertaining to video.

KEY TERMS

AGC-Automatic gain control. Regulates the volume of the audio or video light levels automatically within a camcorder.

Analog-An analog signal that fluctuates exactly like the original stimulus (examples, sweep second-hand clock, phonograph player).

Ambient Sound-Background sound or "wild" sound. Sound that surrounds the scene or location, received by the microphone and recorded onto magnetic tape.

Aspect Ratio-The ratio of the height to the width of the film or television frame. Three units high to four units wide (3:4).

Audio Track-The area of a videotape that is used for recording audio information.

Beam Splitter-An optical device within a color camera that splits the white light into three primary colors: red, green, and blue.

Camcorder-A portable video camera with videotape recorder (VTR) and a microphone attached to form a single unit.

Capstan-An electrically driven roller that rotates and transports the videotape past the recorder heads at precise and fixed speeds.

CCD-Charged-coupled device, also called a chip. A small, solid state (silicon resin) imaging device used in a video camera instead of camera pickup tubes. Inside the chip, image sensing elements translate the optical image into a video signal.

Character Generator-An electronic device used to create words or graphics that may be electronically inserted or "keyed" over the video picture.

Color Bars-A color standard used by the television industry for the alignment of cameras and videotape recordings.

Component-The processing of RGB (red, green, blue) channels as three separate channels.

Composite Signal (Y/C)-(Also called NTSC signal) The video signal in which luminance "Y" (black and white) and chrominance (red, green, blue) and sync information are encoded into a single signal.

Control Track-The area of the videotape used for recording the information necessary to synchronize the all elements during playback.

Digital VTR-A videotape recorder that translates and records the analog video signal in digital form.

Dub-Duplication of an electronic recording. Dub is always one generation away from the original recording.

Dropout-A loss of part of the video signal, which appears as white glitches. Caused by dirty VTR heads or poor quality videotape.

Field-Scanning lines in one-half of one video or television frame. There are two fields (one odd and one even) in a frame. One field equals 262.5 scanning lines, which create a total of 525 standard television lines or one frame. Also known as the NTSC signal (U.S. TV system).

Frame-The smallest unit in television or film, a single picture. A complete scanning cycle of the two fields occurs every 1/30 second. A frame equals 525 scan lines.

Gain-The level of amplification for a video or audio signals. Increasing the video gain increases the picture contrast.

Generation-The number of dubs or copies away from the original recording. The greater the number of generations, the greater the loss of picture quality.

Heads-A small assemble within an audio or video recording system, which can erase, record or playback the signal in electromagnetic impulses.

Helical Scan, or Helical VTR-(Also called slant track). A videotape recording or a videotape recorder in which the video signal is put on tape in a slanted, diagonal way. Because the tape wraps around the head drum in a spiral-like configuration, it is called helical.

Noise-Unwanted sounds or electrical interference in a audio or video signal. In the audio track, there is a hiss or humming sound. In the video picture the interference appears as "snow."

NTSC-National Television Standards Committee. U.S. standards for television or video signal broadcasting. Also known as the composite signal (Y/C).

Pickup Tube-The imaging device in a video camera that converts light into electrical energy (video signal).

Pixel-The smallest single picture element with which an image is constructed. The light-sensitive elements in a CCD (chip) camera.

Preroll-To start a videotape and let it roll for a few seconds before it is put in the playback or record mode so that the electronic system has time to stabilize.

RGB-The separate red, green, and blue color (chrominance), or "C," video signals.

Slant Track-Same as helical scan.

Time Base Corrector (TBC)-An electronic accessory to a videotape recorder that helps make playbacks or transfers electronically stable. A TBC helps to maintain picture stability even in dubbing-up operations.

Video Cassette-A plastic container in which a videotape moves from a supply reel to a take-up reel. Used in all but the 1-inch VTRs.

VTR-Videotape recorder or recording. Includes video cassette recorders.

Y/C-The separate processing of the luminance (Y) and chrominance (C) signals.

VIDEOTAPE RECORDERS

Videotaping is similar to audiotape recording. The electronic impulses of television pictures (video signal) and sound (audio signal) are recorded on the videotape by magnetizing the iron oxide coating on the videotape. During playback, the recorded video and audio signals are converted again by the television set into television pictures and sounds. However, the amount of electronic information is many times greater for video than for audio recording.

RECORDING SYSTEMS

There are many different systems of treating and recording the video signals. Videotape recording systems can be divided roughly into three subsections: analog and digital; composite (Y/C), and component; and tape formats.

Analog and Digital Systems

Both analog and digital systems are used in naval imaging facilities. The analog system is easier to understand if you think of it in the same terms as a record and a phonograph. Analog systems record the continually fluctuating video signal that is created and processed by a video source (camera) on videotape. During playback, the recorded information is retrieved as an identical, continually fluctuating signal from the videotape.

Digital-video systems work on the same principle as compact disks (CD) used in your home stereo or office computer. Digital-video systems convert the analog video signals by sampling (selecting parts of) the scanned image. It then translates the scanned image into millions of independent, fixed, values called **pixels.** A pixel is the smallest single picture element from which images are constructed. Each pixel has its own color (hue and saturation) and luminance values. These values are expressed as binary numbers (series of zeros and ones). The binary numbers are then stored on, and retrieved from, videotape or other storage mediums, such as large-capacity disks.

Composite (Y/C) and Component

Composite (Y/C) and component all refer to the way the video signal is treated in the videotape recorder. A composite video signal means that the luminance information ("Y" signal), chrominance information ("C" signal), and the sync information are combined into a single signal (Y+C+sync). Standard television information is designed to operate with composite video signals. Only one wire is required to transport a composite video signal. This composite signal is usually called NTSC, because the electronic specifications for a composite video signal were adopted by the National Television Standards Committee.

The major disadvantage of a composite signal is that slight interference exists between the chrominace and luminance information. This interference becomes more noticeable through each videotape generation.

In a true component system, the R, G, B channels are kept separate and treated as separate red, green, and blue video signals throughout the entire recording process. Each of the three signals remains separate even when laid down on the videotape. The component system requires three wires to transport a video signal. This means that all equipment used in the component system requires three wires to handle the video signal that is incompatible with the NTSC system.

When the video is going to be televised, the signals of the Y/C and component systems must be combined into a single NTSC composite signal before it can be broadcast.

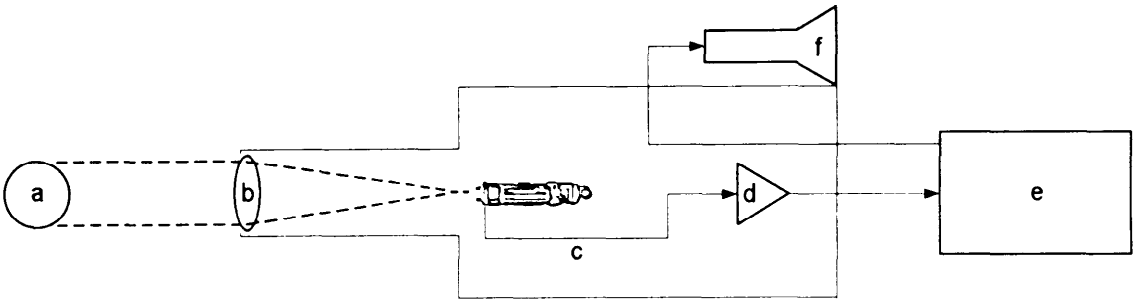


Figure 13-3.–Basic principles of a motion-video camera.

Tape Format Systems

The classification of a videotape recorder VTR by tape width was particularly important in the earlier days when the quality of the videotape recording was directly related to the tape format. The old standard used to be, the wider the tape, the higher the quality of the recording. Anything smaller than the l-inch videotape was considered small format and inferior in quality. Today, 1/2-inch Betacam SP can provide equal or superior quality compared to the large-format, l-inch machines. The Hi8 video camera (8mm) is superior to the 1/2-inch VHS cameras. Today, "small format" is used mainly to describe small, highly portable television equipment, such as small camcorders. Like all state-of-the-art electronic equipment, smaller no longer implies inferior quality.

The quality of the tape itself has much to do with the quality of the picture. No matter how sophisticated the video hardware, the resulting picture is only as good as the videotape being used.

Videotape is a ribbon of polyester film base coated with magnetic iron-oxide particles. The surface of the tape, or emulsion side, that faces the video recorder heads is highly polished to maximize tape-to-head contact and to minimize wear on the heads.

Head clogging results when oxide comes off the tape and gets caught in the head gaps of the recorder. If the tape clogs the video recording heads, you cannot play back or record. Normally, the heads will clog after recording or playing back half a dozen or so tapes. You should have the heads cleaned according to the manufacturer's recommendations or according to Planned Maintenance System (PMS) requirements.

Videotape dropout occurs when a piece of magnetic oxide or coating on the tape flakes off or is rough, causing a "hole" or line of missing information in the picture when it is viewed on the monitor. Dropout appears on the TV screen as little black or white lines, darting across the picture. The main causes of dropout are dirty heads or imperfections in the tape. Once dropout occurs, it cannot be replaced or corrected on the tape.

There are no black-and-white or color videotapes. Any videotape will record either black and white or color. Black and white or color depends solely on whether the camera and monitor are black and white or color.

THE VIDEO CAMERA

Refer to figure 13-3 to help clarify how a video camera operates. In the video camera, an image (a) is gathered by the camera lens (b), and focused on the face of the camera pickup tube (photocathode) or a solid-state imaging device (c). The face or screen of the photocathode is covered with thousands of light sensitive dots. As light from a particular part of the scene falls on each dot, the dot becomes electrically charged. A charge pattern is built up proportionally to the brightness of the scene. An electron beam in the pickup tube emits a steady beam of electron particles. This electron beam scans the charged pattern on the photocathode and reads over it in a series of lines. The scanning beam neutralizes each picture element or dot and produces varying electrical currents (the video signal). These currents are proportional to the charge pattern which are proportional to the light transmitted through the lens.

The current or video signal (picture) is amplified (d) and then recorded on tape by rotating heads (e) and then converted back to visible screen images in the viewfinder (f).

As each dot on the tube screen is scanned, the dot gives up its information and is wiped clean so the tube screen can respond to any new light it receives.

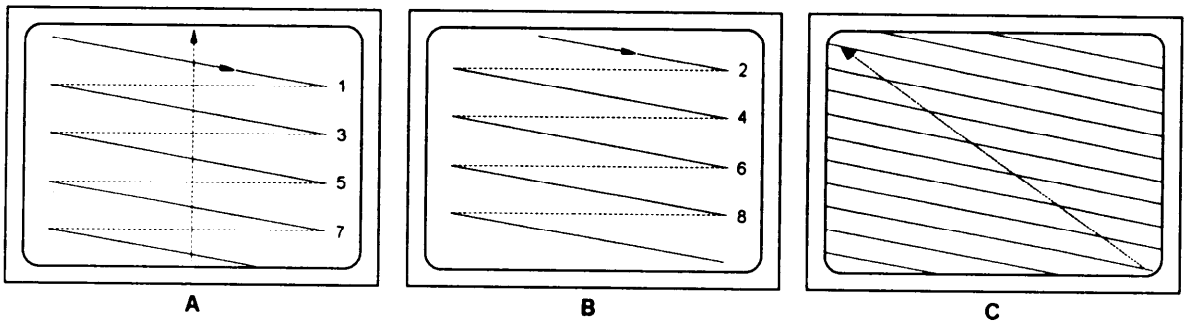


Figure 13-4.–Video scanning.

Figure 13-4 illustrates how this scanning process takes place. The electron beam first scans all odd-numbered lines, from left to right (a). When all odd-numbered lines have been scanned, it makes up a field. One field consists of 262.5 lines. After the odd-numbered ones are scanned, the beam jumps back to the top of the screen. At this point, the beam is so weak that it does not affect the screen. Back at the top of the screen the beam starts scanning the even-numbered lines (b). When all even-numbered lines are scanned a second field is formed. The two fields make up a frame (c) or one complete television picture. A frame consists of 525 lines. After completing a frame, the beam returns to the top to start with another first field.

This charge-forming-and-scanning is a fast, continuous process. The complete camera tube screen (frame) is scanned 30 times per second.

The motion-video camera picks up reflections of light from the scene while the microphone picks up sound. At the same time, the camera changes the light reflections into electrical impulses, and the microphone changes the sound into electrical impulses.

This is basically the way a black-and-white video camera works. A color video camera works on the same principle; however, a color video camera has three tubes. Through the use of a beam splitting device and filters, one tube forms a red image, a second tube forms a green image, and the third tube forms a blue image. The three tubes have identical scanning patterns, so the picture signals they produce are identical, except they differ in color.

During a video recording, the videotape moves past a rotating **head** that "writes" the video and audio signals on the videotape. During playback, the rotating head "reads" the magnetically stored information off the tape Some VTRs use two or four heads for their record/play (write/read) functions. Digital VTRs have even more

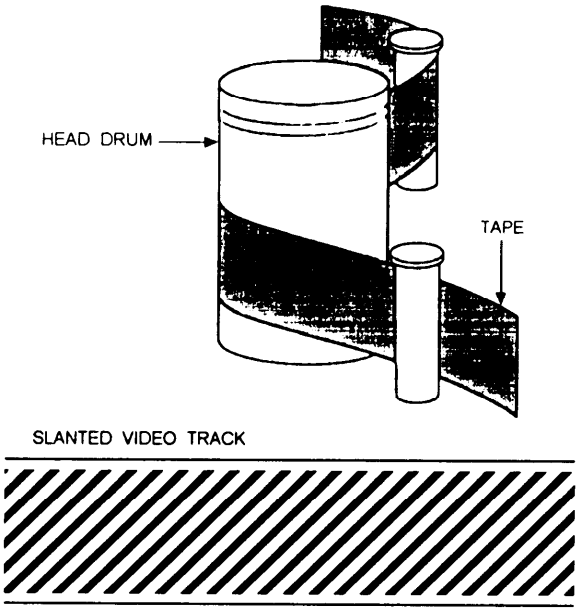


Figure 13-5.–Helical scanning system.

read/write heads. For explanation purposes a VTR with two record/play heads is discussed in this chapter.

Helical, or Slant-Track, System

The two heads are mounted opposite each other, either on a rapidly spinning head drum or on a bar that spins inside a stationary head drum. When the bar spins inside a stationary head drum, the heads contact the tape through a slot in the head drum. The tape is wound around the head drum in a slanted, spiral-like manner. This permits more tape area to contact the head, allowing the transfer of large amounts of video information (fig. 13-5). If the head contacted only the width of the tape, extreme tape or drum speed would be necessary. Because the Greek word for spiral is helix, this tape wrap, and often the whole video-recording system, is called the helical scan, or slant track

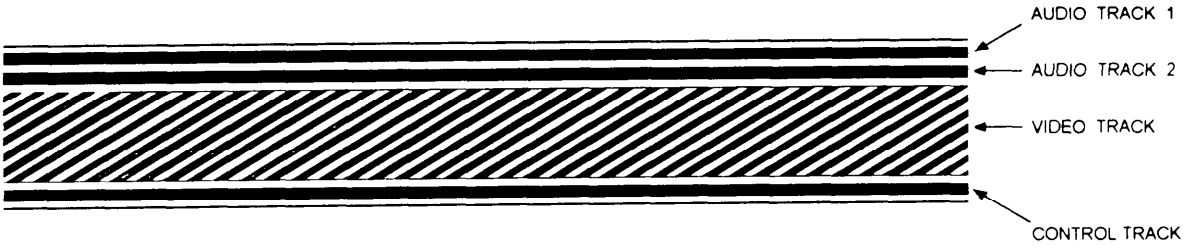


Figure 13-6.–Basic videotape track system.

Most videotape recorders put at least four separate tracks on the tape: the **video track** that contains the picture information, two **audio tracks** that contain all sound information, and a **control track** that controls the videotape and rotation speed of the video heads (fig. 13-6).

VIDEO TRACK.-When video signals are recorded in the normal NTSC composite configuration, one pass of the head records a complete field of video information (Y+C). The next pass of the head, (or, if you have a two-head machine, the second head) lays down the second field right next to it, completing a single video frame. Two fields make up a single frame. The two heads must "'write" sixty tracks (thirty frames) for each second of NTSC video. In the four-head VTR, one pair of heads records at normal tape speed and the other pair records at a slower speed.

AUDIO TRACK.-The audio tracks record the audio signal. They are usually recorded by fixed recording heads that are near the edge of the tape and run along the length of the videotape. Because of the demand for stereo audio and for keeping certain sounds separate even in monophonic sound, all VTR systems provide at least two audio tracks.

CONTROL TRACK.-The control track contains evenly spaced blips or spikes, called the **sync pulse,** that mark each complete television frame. These pulses synchronize the tape speed and the rotation speed of the recording heads. This allows the tape to be played on a similar machine without picture breakups. Because the control track marks each frame of recorded video, it also aids in videotape editing.

Hi8 Track System

Because space is so limited in 8mm videotape, these systems squeeze the automatically generated **time code** and other data between the video and audio portion of a single-slanted track The time code has been developed to provide a precise editing reference by recording the exact frame address onto the tape. The 8mm time code is digitally recorded by units of hour, minute, second, and frame by the video heads. The 8mm time code is used only for 8mm format and is not compatible with other recording formats.

The Hi8 VTR splits each slanted track into audio frequency modulation (AFM) and video information. It also uses a pulse code modulation (PCM) audio track The audio technology used in an Hi8 VTR is superior to video home system (VHS). The video/AFM audio track and the PCM audio track are separated by the time-code data (fig. 13-7).

VIDEO MONITOR

For viewing purposes, you must playback the recording either to the transmitter or directly to a receiver (TV set or monitor). At the receiver, the video and audio signals are separated and processed by separate circuitry. This circuitry changes the video and audio signals back to sound that you can hear and pictures that you can see. The sound is reproduced at the loudspeaker, and the picture is reproduced on the face of the cathode-ray picture tube.

A primary part of the monitor system is the cathode-ray tube. A type of cathode-ray tube is used in

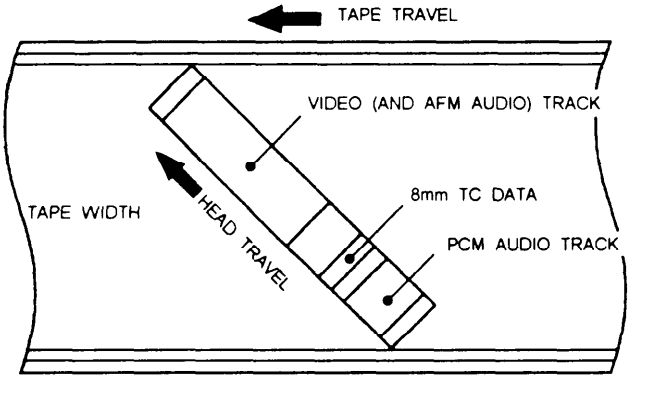


Figure 13-7.–Hi8 VTR tracks.



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Figure 13-8.–Hi8 video camera.

the camera to convert light rays into electrical impulses. The cathode-ray tube converts the electrical impulses back into light in the receiver (monitor).

CAMCORDERS

As a nonspecialized Photographer's Mate without a motion-media NEC 8143, you will be concerned mostly with recording motion-video images using a single camcorder. A camcorder has a single VTR directly attached to the camera to form a camera and recorder unit.

Each camcorder comes with manufacturer's instructions on how to use the equipment. Because there are a great variety of camcorders in the Navy, you must consult the instruction manual supplied with your machine for best results. One common motion-video camera used in the Navy is the Hi8 video camera (fig. 13-8).

The Hi8 camcorder is a small camera-VTR unit that records amazingly high-quality pictures and sound compared to a video home system (VHS) camcorder. It uses a special 8mm (about 1/3 inch) cassette with metal-oxide coated tape. These tapes are similar in size to an audio cassette tape.

A tempting practice while operating a camcorder is to shoot all videotape in the automatic mode. On the Sony Hi8 camcorder, when the AUTO LOCK switch is set, the iris, focus, white balance, sensitivity, and shutter speed (1/60) are set and adjusted automatically. If left unnoticed, there are several circumstances under which the AUTO LOCK mode will produce poor or undesirable results. You, as the camera operator, must pay attention to the subject and the surrounding situations to produce quality motion-video coverage; in particular, brightness levels, focusing, color temperature of the light source, and subject movement.

Brightness Levels

The single greatest influence on picture quality is the brightness level. When the brightness level is too low, the recorded image looks grainy and flat. By familiarizing yourself with the brightness level of the subject, you can improve your recordings tremendously. In situations where the light level exceeds 100,000 lux, such as snow-covered scenes or a beach scene on a clear summer day, an ND filter is required. Under other daylight and bright, indoor conditions, the automatic iris is capable of adjusting to provide excellent results; however, in a low-light situation, such as spaces onboard ship, auxiliary lighting may be required to provide clear, sharp images. Another alternative, when available on your camcorder, is to increase gain. By increasing the gain, you increase the level of amplification of the video signal. This increases the contrast and provides a higher-quality recorded image.

In some situations, such as high-contrast scenes or backlit subjects, you must adjust the iris manually. Just like the aperture on a still camera, when the subject is backlit, open up the iris. When the subject is too bright, you must close down the iris.

Manual Focusing

There are situations when you must manually focus the camcorder to obtain sharp images. In the autofocusing mode, the system uses a sensor at the center of the viewfinder screen to adjust the focus automatically; therefore, in situations where there is insufficient light, the subject is strongly backlit, or with subjects consisting of flat colors or little contrast (such as bulkheads or the sky), the autofocusing mode may not function accurately.

Other situations in which you should use manual focusing are as follows:

- When the subject has finely detailed repetitive patterns
- When one subject is close to the camera and another is far away
- When the subjects are located behind screens, nets, or frosted glass
- When objects pass between the camera and the primary or intended subject

- When using lenses or filters to create special effects

You may also want to use manual focusing to conserve battery power.

CAUTION

NEVER attempt to force or manually focus the focus ring when the camera is set in the autofocusing mode. This may damage the camera.

White Balance

Usually the auto white balance function of a video camera operates sufficiently in the automatic position; however, there are situations when the automatic light balance may not work correctly. Some of these cases are as follows:

- When the light reflecting from the subject is different from the light that is illuminating the camcorder
- When shooting a monochromatic subject or the subject is against a monochromatic background
- When recording under a sodium lamp, mercury lamp, or a white fluorescent lamp
- When recording outdoors under neon lights or fireworks
- When shooting scenes just before sunrise or right after sunset

To white balance a motion-video camera manually, you can follow a simple procedure. Normally a white lens cap, made of a diffuse plastic material, is supplied with the camera. You also can use any white object to white balance the camera, providing the white object is illuminated under the same conditions that you will be shooting. To white balance, you simply place the white lens cap over the lens, point the camera at the light source, and press the white balance button. Remember, when in the manual white-balance mode, if the color temperature of the light changes, you must reset the white balance.

To create special effects, there may be times when you want to “lie” to the white balance sensor; for example, you may want to produce motion video that has a warm color balance, such as that which occurs at sunrise or sunset. To produce video coverage with warm characteristics, you can "white balance" the video camera on a blue object or any of the complimentary colors. When you record the scene, an overall yellow cast is produced. You can also use filters to create various effects.

Shutter Speed

When the Hi8 camera is set in the AUTO LOCK position, the shutter speed is set at the normal speed of 1/60 second. When fast-moving subjects are recorded at the normal shutter speed, the pictures are not recorded clearly. You can improve the image quality by increasing the shutter speed.

Because more light is required when shooting at higher shutter speeds, you should not try to shoot fast objects under poor or low-lighting conditions. Outdoors on clear days, you can record fast-moving subjects at shutter speeds of 1/2000 to 1/10000. On overcast days, shutter speeds of 1/250 to 1/1000 are recommended. While handholding the camera indoors, you may want to provide a more stable image. In this case, a shutter speed of 1/100 is recommended. Do not use a shutter speed of 1/250 or higher indoors unless you use additional artificial lighting.

CAMERA-HANDLING TECHNIQUES

In handling a motion-media camera, two words you must keep in mind are STEADINESS and SMOOTHNESS. When you are shooting motion media, the camera must be held steady, and deliberate camera movements (such as tilts, pans, dollys, zooming, and so on) must be made smoothly. When viewed, the images undergo a high degree of enlargement. Image movement caused by camera unsteadiness is distracting to the audience.

HANDHOLDING THE CAMERA

Very few division officers or chiefs in an imaging facility expect a cameraperson to shoot every scene from a tripod. Tripods cut down on maneuverability. When you are shooting uncontrolled action, “shooting from the hip” is common practice. During a fast-breaking event, it is usually the only way you can get the required coverage. When there is plenty of action in the scene, people do not notice the effects of excessive camera movement by the cameraman.

There are many occasions when freedom of movement and mobility in handholding the camera are essential. You can still produce acceptable motion-video coverage if you use your body as a camera support and

shock absorber. When handholding a camera, keep your arms in close to your body and your legs and feet spread about a shoulder width apart. Bend your knees slightly, keeping your weight on the balls of your feet. Lean your body backslightly for better balance. The camera should be over your knees for greatest stability. Hold the camera firmly against your face and place your hand in the camera strap.

Control your breathing while shooting. Each breath you take causes the camera to rise and fall slightly. The technique of taking a deep breath, exhaling a little, and holding the rest while you shoot is an effective way to help eliminate camera unsteadiness. When shooting a long scene, breathe as evenly and slowly as possible.

For added steadiness when handholding a camera, you can lean against something, such as a tree or a wall. Another method for handholding a video camera is to kneel on one leg and rest your elbow on the raised knee. When you must pan the camera, keep your elbow free and pivot your body at the waist.

When handholding a video camera, keep the following facts in mind to reduce the shakiness problem:

- Concentrate on handholding the camera steady while using a wide-angle lens. Your shakiness will be reduced considerably. When using a wide-angle lens, you must get as close to the subject as possible to provide an acceptable image size.

- :Shakiness is directly proportional to the focal length of the lens. Slight shakiness may be almost unnoticeable with a wide lens. With a long lens, the same amount of shakiness destroys the entire scene. (See table 13-1.)

- Give yourself a steady platform. Before you squeeze the record button, inhale, then partially exhale. Now, squeeze. Do not pull or jerk the record button. Lean against a building, a tree, or the side of a car. Any support of this nature may provide more steadiness than free standing.

TRIPODS

A tripod can literally be considered the “basis” for most good motion-media products. To help you realize just how important a tripod is for shooting motion media, consider handholding a movie projector. You cannot hold the projector steady for any period of time. The picture weaves around on the screen and is very distracting to the viewers. ‘The same result is created when a motion-video camera is handheld, but in this case, images within the picture area appear to weave around because of camera movement. The image you see in the camera viewfinder is so small that you may not notice the camera movement. It is easy to think you are holding the camera steady. Bear in mind that the slightest amount of camera movement is magnified many times when the image is played back

While not all situations permit the use of a tripod, the use of a folded tripod as a unipod is preferable to shooting without camera support. Even the lightest weight, so-called “handheld” video camera produces much better results when supported adequately.

Camera steadiness is only one advantage of using a tripod. When using a tripod, you automatically take more time to compose and check scenes before recording them.

RECORDING FROM A MOVING VEHICLE

Sometimes you may have to record from a moving vehicle, such as a truck or a boat. For this type of assignment, the problem of holding the camera steady becomes even more difficult. In this situation you should handhold the camera, because a tripod transmits vibrations and movements from the vehicle to the camera. Keep your weight on the balls of your feet, and keep your knees flexed so you can sway and bend as the vehicle rolls, pitches, or bounces. Watch the horizon in the viewfinder. A tilted or wobbly horizon is very detracting when being viewed. When shooting from moving vehicles you should use a short focal-length lens and a fast shutter speed.

CAUTION

When shooting from a moving vehicle, you must follow all safety precautions. Use common sense, you do not want to jeopardize yourself or the video equipment.

PANNING

One of the most commonly abused motion-media techniques is panning. Panning is moving the camera from left to right or right to left. Moving it up or down is called tilting.

Only a few subjects require panning while you are actually taping. The use of panning can keep a moving procession, such as a marching unit in view, show a sweep of landscape, or show the relationship between objects or subjects.

There are definite and clear-cut rules and methods for panning. The very first is PAN ONLY WHEN PANNING IS NECESSARY. Panning a camera without a valid reason produces images that only irritate the viewer.

Making Pans

Making professional-quality pans takes practice and experience; however, you can easily gain this skill. One of the first and most important points to remember is to pan slowly and smoothly. Panning appears faster on the screen than it actually is; therefore, camera pans must be slow and consistent while maintaining a smooth, steady panning motion. When panning a moving object, you must keep pace with the object and allow for subject lead room. Panning too fast may make the viewer dizzy; therefore, it is advisable not to position the camera too close to the subject. The farther the subject is from the camera, the slower the pan required to follow the subject at a given speed.

Throughout the entire pan, the camera must be level without up and down wobbling. Whenever possible, rehearse the pan before you actually shoot. Know exactly where and when you want to start and end the pan. Practice the pan several times without recording on tape. Make the pan shot only after you can do it smoothly and accurately. The smoothest and best pans are made with the use of a tripod or other suitable camera support. Good handheld pans are always difficult to achieve.

Before you pan with a tripod, be sure the camera is absolutely level. Check the camera for level throughout the entire arc of the pan with a spirit bubble level located on top of the tripod head.

To produce better pan shots, position yourself comfortably for the end of the pan. Then, keeping your feet in this position, “wind” yourself around to the start pan position. As the pan progresses, "unwind" into the most comfortable position for a smooth stop. When using a tripod, be careful not to bump into the tripod as you are shooting.

Tilting the Camera

Moving a camera up and down vertically is called tilting. Tilting is useful when you want to photograph tall structures in one shot or to follow action, such as a parachute jumper.

Most of the rules that apply to horizontal panning apply equally well to tilting. As with horizontal panning, tilting should be used only when stationary shots cannot accomplish the desired effect.

A tilt should be made slowly and smoothly. Know where and when you want to start and end the tilt. Usually, you start and end a tilt with a stationary shot.

To photograph a tall building or object, you should normally start the tilt at the bottom and move up. This is the way people naturally look at tall objects. There may be times, however, when you may start a tilt at the top and move down; for example, you might show flames coming out from the top-floor windows of a skyscraper, then tilt down to show the fire trucks arriving. When you are following action with a tilt, the type of action determines the direction of tilt. Also, as with a horizontal pan, you should show enough of the surrounding area so the audience can associate the subject with its location.

SHOT VARIETY

One of the great advantages of motion media is that it involves the viewers in the action. Viewers feel that they are there and participating in whatever is happening on the screen. They can be made to feel that they are moving along with the action as it develops, they become even more involved. Changes in the camera angle permit the viewers to see the same subject from several different positions, as though they were moving within the scene. This adds variety and makes the images they see more interesting because something is a little different about each one. However, be careful to keep these camera-angle changes from confusing the viewers. If the changes are so different that they seem to be in other locations, the viewers lose their orientation. When choosing the camera angle, be sure you present the subject from the best possible vantage point and create the proper psychological effect.

MOVEMENT

When you can control the angle at which the action passes across the camera lens axis, your shots will show the apparent speeding up or slowing down action. Objects moving at right angles to the lens (across the lens axis) appear to be moving faster than objects approaching the lens directly or going straight away from it. You can vary the apparent speed of objects by selecting various camera angles.

Good motion-media footage needs movement. Movement can take place in front of the camera, of the camera itself, and of course in the picture itself. The

movements necessary for good motion video are divided into three categories:

- Primary movement (movement of the subject)
- Secondary movement (movement of the camera)
- Tertiary movement (movement produced by successive shots from different cameras)

Primary Movement

Movement in front of the camera, usually that of the subject, is called primary movement. Primary movement toward or away from the camera is stronger than lateral movement. More emphasis is created by having the subject move toward or away from the camera. Exits and entrances are more impressive when they occur toward or away from the camera. Lateral movement of a subject should always be lead with the camera The viewer wants to know where the subject is going, not where it has been.

Secondary Movement

Secondary or camera movement is normally done in television studios. Secondary movements include: pans, tilts, dollys, zooms, trucks, and pedestal movements. Secondary movements are used to follow primary movement, to change or adjust picture composition, or to emphasize or dramatize something. Secondary movements must have a valid purpose. Do not make them just for something to do.

DOLLY.-A dolly is a piece of equipment that normally requires a small crew to operate. You can dolly-in to increase the size of an object gradually on the screen or dolly-out to decrease the size of the object on the screen. Likewise, dollying decreases or increases the field of view. A zoom lens can be used for the same purpose as a dolly. During a zoom, the camera does not move; therefore, perspective does not change as it does during a dolly.

TRUCK.-A truck is a piece of equipment that is basically a tripod with wheels. The camera is used to follow lateral subject movement or you could truck the camera along the objects. In either case, camera-to-subject distance does not change.

PEDESTAL.-A pedestal is used to either raise or lower the camera. Pedestalling can provide the audience with a view looking down on the subject or up at the subject. A pedestal may also be used to compensate for tall or short camerapersons or subjects.

Tertiary Movement

Tertiary movement results from a sequence of shots from two or more cameras. When two or more cameras are used, you can select from a variety of pictures and determine which picture is to be recorded and when. When more than one camera is used, you can easily emphasize, de-emphasize, show action and reaction in rapid or slow succession. The effect of tertiary movement is accomplished through videotape editing.

COMPOSITION

Video images, like still photographs, are subject to the aesthetic rules of picture composition. There are, however, factors peculiar to video that more or less influence television composition. These factors are as follows:

- The small monitor requires objects to be shown relatively large so they can be seen clearly on a small screen. You must shoot more extreme close-ups (ECU), close-ups (CU), medium shots (MS), few long shots (LS), and very few extreme long shots (ELS).
- The 3:4 aspect ratio of the picture cannot be changed so all picture elements must be composed to fit it. The aspect ratio is the ratio of picture height to width. There is no vertical format in television. You must always think horizontal format.
- The video camera is the eyes of the viewer. Therefore, camera movement, as well as the static arrangement of elements within the frame, must be considered.
- When shooting uncontrolled action, you may not be able to predetermine composition. Sometimes all you can do is correct certain compositional errors.

In motion media, the picture on the screen is referred to as a shot. A shot is one continuous camera run from the time the recording starts to the time the recording stops. A shot may last a few seconds, several minutes, or the entire program. A motion-video cameraperson must always think in terms of shots.

Most rules of composition in still photography apply equally well to composition in motion media. Composition was covered earlier in chapter 5. The

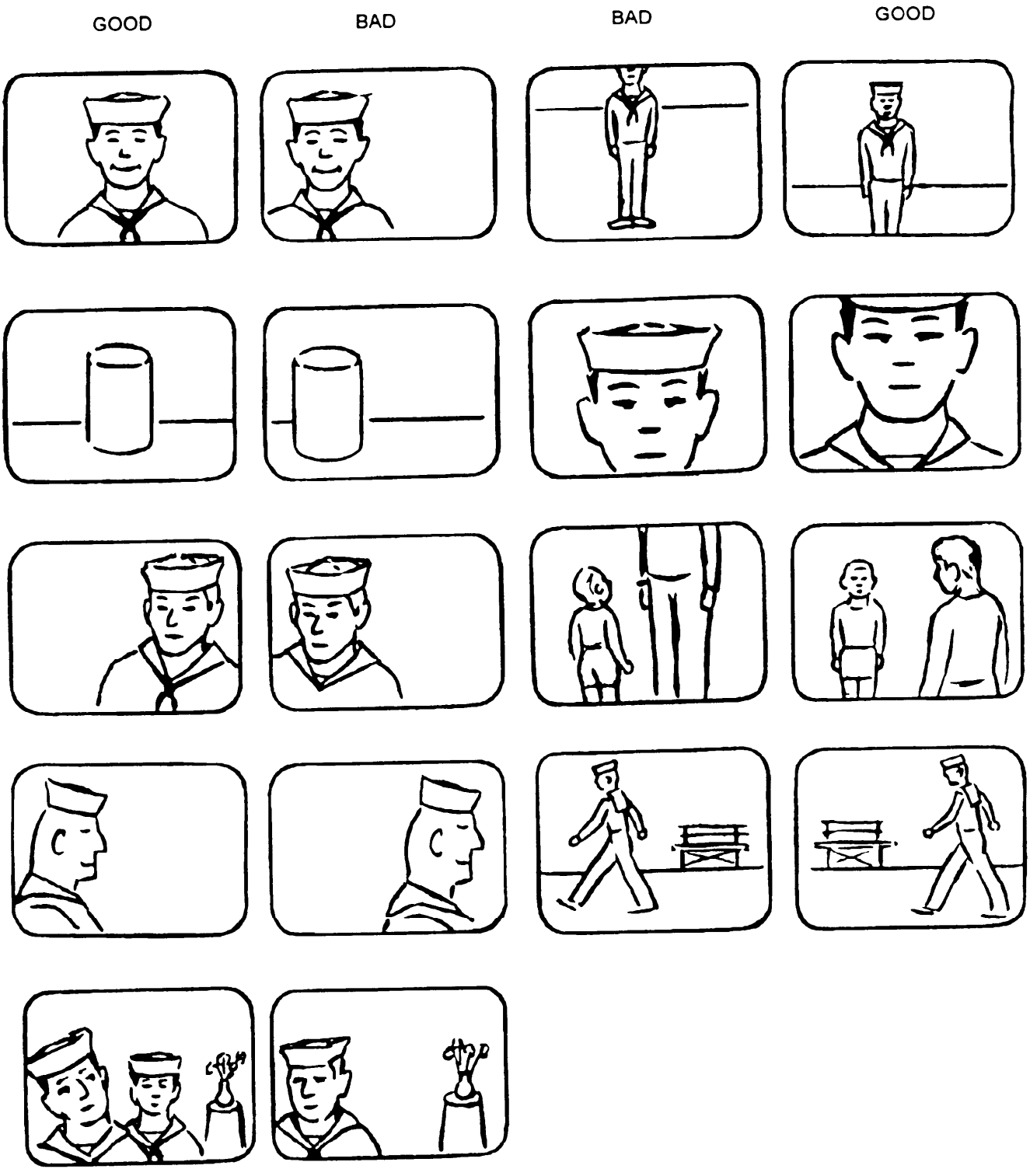


Figure 13-9.–TV framing.



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Figure 13-10.–Long shot, medium shot, and closeup shot progression.

simple line drawing examples of TV framing (fig. 13-9) indicates how to stage and show elements within the confines of the small 3:4 fixed aspect ratio of a television picture.

Use high- and low-camera angles with caution. High angles tend to shorten the legs of a person. Low angles may distort the body and face of the subject. Of course, watch for objects that seem to be growing out of or are balanced on a person's head.

Area of Talent Included

Most motion-media assignments involve people. You may find it convenient to identify people shots by the section of the body that is included in the frame. The person's head is usually in the top of the picture; therefore, shots vary according to the lowest part of the talent shown at the bottom of the screen. Thus the terms used to describe various people shots are as follows: full figure shot, knee shot, thigh shot, waist shot, bust shot, head shot, tight head shot.

Number of People Included

The shot designations that are easiest to remember are the ones that refer to the number of people included in the picture. When only one person is to be shot, it is a one-shot. Obviously, a shot that shows two people is a two-shot, three people make a three-shot, and so on; however, when five or six people are pictured it is called a group-shot. A crowd-shot is when a large group of 20 or more people is being framed.

BASIC SEQUENCE

During motion-media recording, you can change the image size by changing the camera-to-subject distance or by using a zoom lens (which also changes the field of view).

When recording an event on motion media, there are three basic shots or sequences you must use: long shots (LS), medium shots (MS), and closeup shots (CU) (fig. 13-10). The type of shot being used can limit or increase the amount of visual information presented to the viewer. Long shots generally establish a location. A medium shot is used primarily as a transition between a long shot and closeup shot. Closeup shots create impact and provide more detail and less visual information pertaining to the subject's surroundings.

Shot classifications can be broken down into five categories: extreme long shots, long shots, medium shots, closeup shots, and extreme closeup shots.

Extreme Long Shots

An extreme long shot (ELS) is used to portray a vast area from an apparently very long distance. An ELS is used to impress the viewer with the immense scope of the setting or scene. An ELS is best usually when made with a stationary camera. Camera panning for an ELS

should be avoided unless panning is needed to show more of the setting or to help increase audience interest in the film. An extreme long shot can be used to give the audience an overall view of the setting before the main action is introduced The use of an ELS is an effective way to capture audience interest from the start. Extreme long shots should normally be taken from a high vantage point, such as from a tall building, a hilltop, or an aircraft. Extreme long shots are used primarily in films and are seldom used in video productions.

Long Shots

A long shot (LS) shows the entire scene area where the action is to take place. The setting, the actors, and the props are shown with an LS to acquaint the audience with their overall appearance and location within the scene. An LS is used to establish all elements within the scene so the audience knows who and what is involved and where they are located An LS, therefore, tells where. It establishes where the action is taking place.

The subject's entrances, exits, and movements within a scene should normally be shown with an LS when their locations in the scene are significant. Following actors from location to location within a scene area with closeup shots confuses the viewer about the location of the subject within the scene.

The composition for an LS is usually 'loose," giving room for the subject to move about. While this may make identification of actors somewhat difficult, an LS is usually short and the subjects will be identifiable in closer shots.

Medium Shots

A medium shot (MS) is usually used between a long shot and a closeup shot. After the scene location has been established with an LS, the camera is moved closer to the main subject or a longer focal-length lens is used to bring the main element of the scene into full frame or near full-frame size. A medium shot tends to narrow the center of interest for the audience and answers the question **"what."**

In an MS, actors are usually photographed to show them from the waist up. An MS is normally sufficient to show clearly the facial expressions, gestures, or movements of a single actor or a small group of actors.

With an MS, movement of the subject can be followed with a pan or other camera movement while still showing enough of the surroundings so the audience does not become disoriented. Motion-media coverage should normally progress from a long shot, to a medium shot, to a close-up, then back to a medium shot. This reestablishes the scene location or the actors within the scene.

Closeup Shots

The closeup shot (CU) fills a frame with the most important part of a scene. The CU should include only action of primary interest The portion selected of an overall scene, such as a face, a small object, or a small part of the action, may be filmed with a closeup shot. Close-ups give the audience a detailed view of the most important part or action within a scene. Close-ups also help to build audience interest in the film. The CU shot can be used to "move" the audience into the scene, eliminate nonessentials, or isolate a significant incident.

As a motion-media cameraperson, one of the strongest storytelling devices you have are close-ups. Closeup shots should be reserved for important parts of the story so they deliver impact to the audience.

Extreme Closeup Shots

Very small objects or areas or small portions of large objects can be photographed with an extreme closeup shot (ECU), so their images are magnified on the screen. Small machine parts, such as calibrations on a ruler or a match at the end of a cigarette, can be very effective when shown on a full screen in an ECU.

Do not forget, you must change camera angles between shots within a shot sequence.

CONTINUITY

Motion media should present an event in a continuous, smooth, logical and coherent manner. When this goal is reached, the film has good continuity. Continuity plays a major role in the success or failure of a project. Without good continuity, a motion video would be nothing more than a jumbled mass of unrelated still-pictures. On the other hand, good continuity in a film encourages the audience to become absorbed in the film. Continuity then is the smooth flow of action or events from one shot or sequence to the next. Continuity is the correlation of details such as props, lighting, sound level, image placement, and direction of movement across the screen between successive shots of the same piece of action.

The shooting of all motion media should be based on a shooting plan. This plan may be as simple as a few scribbled notes, or it can be an elaborate script. The better the shooting plan, the better your chances of success in achieving good continuity. Another way you can learn to create good continuity is to watch and

analyze "Hollywood" movies. The next time you see a Hollywood production, notice how the action flows smoothly from shot to shot and from scene to scene. Try to visualize the techniques and camera angles that were used. Then, on your next assignment, plan them first, then use some of these professional techniques to achieve good continuity.

The first step toward good continuity in your films is the planning beforehand. You should plan your continuity and put your ideas on paper. Do not get the idea that all your shots have to follow a written script. News events, and other uncontrolled action, are usually shot without a script; nevertheless, you should be able to anticipate action and prepare a mental script. The information you must know before starting to shoot is what scenes and actions are needed to satisfy the requestor.

SCREEN DIRECTION

In motion-media photography, the direction a person or object either looks or moves can cause continuity problems. The direction a person or object looks or moves is called screen direction. When a look or move in a particular direction is unaccountably changed from one shot or scene to another, the continuity of the film is disrupted. Any change in screen direction must be explained or the subject may suddenly change screen direction and appear to be going the wrong way.

How the camera "sees" the action-not how the action actually appears-is important. In other words, the audience judges the action by its screen appearance, not by the way it actually appeared during filming.

There are four types of screen direction. They are as follows: neutral, constant, contrasting, and static.

Neutral Screen Direction

Neutral screen direction movement shows subjects moving toward or away from the camera. Because neutral screen direction movement is nondirectional, it may be used or intercut with scenes that show movement in either right or left directions. The following are neutral screen direction movements.

- Head-on and tail-away shots show the subject moving directly toward or away from the camera. For an absolutely neutral shot, only the front or back of the subject should be shown. When one side of the subject is shown, the shot will show some direction and not be absolutely neutral. Entrance and exit shots also show direction and therefore are not neutral.

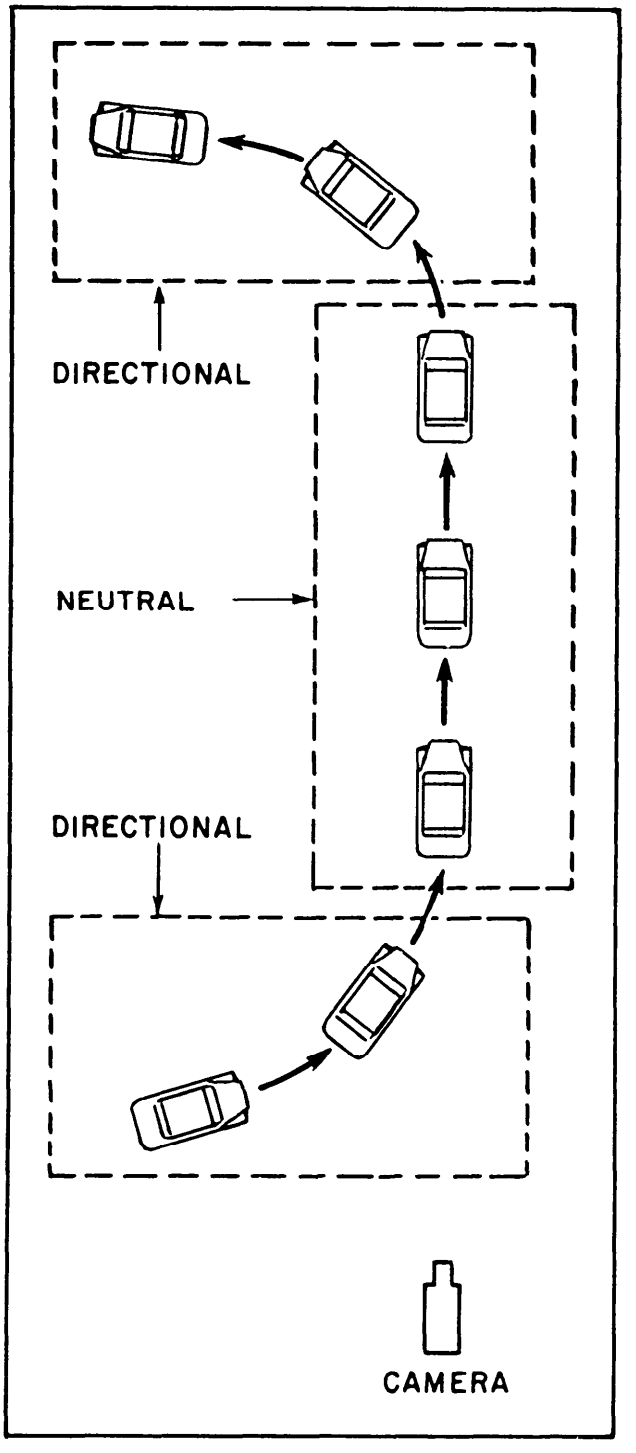
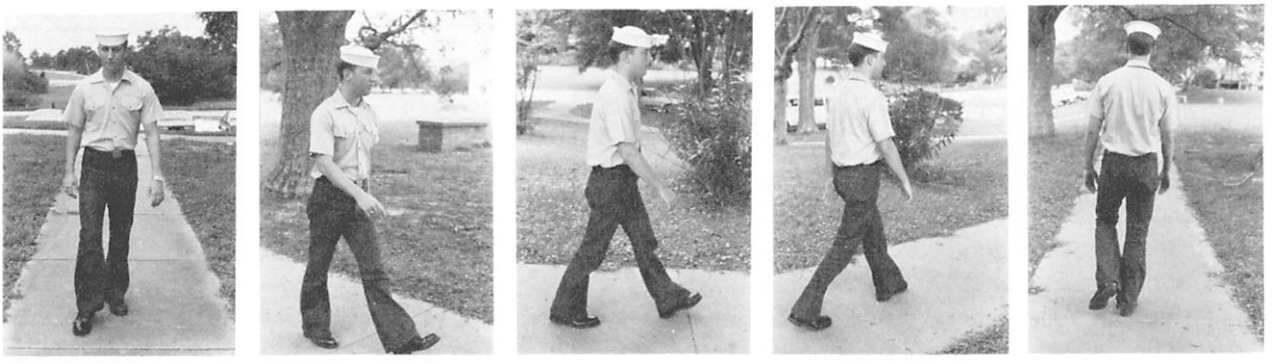


Figure 13-11.–Showing a change in screen direction.

A shot can start as a neutral shot and transition into a directional shot, or vice versa; for example, start with a head-on shot of a car and continue filming as the car turns to the right and exits the frame, or start with a direction showing a shot of the car entering the frame from the left, and continue filming as the car turns left to a tail-away neutral shot (fig. 13-11). These types of



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Figure 13-12.–Showing change of screen direction.

shots can be used to change screen direction by temporarily showing a neutral condition between two shots when the subject moves in opposite directions.

- Tracking shots are accomplished by moving the camera directly ahead or behind the subject, either leading or following the subject, respectively.

As with head-on or tail-away shots, tracking shots are neutral only when the subject is not shown entering or leaving the frame and when only the front or back of the subject is shown.

- High-or-low camera angle shots-The subject moves directly toward and under or over the camera so, the subject exits at either the bottom or the top of the frame. Examples: a train, shot from a high-camera angle, may move directly under the camera and exit at the bottom of the frame, or an aircraft may take off and move over a low-angled camera and exit at the top of the frame.

- Subjects traveling abreast shots-Two or more subjects move directly toward the camera and split up to exit the frame on both sides of the camera, or enter the frame on both sides of the camera and join up, moving directly away from the camera.

A neutral shot inserted between two shots of a subject moving in opposite cross-screen directions distracts the audience momentarily to allow for the change in direction.

To open a sequence, you can use a head-on shot to bring a moving subject from a distant point toward the audience. To close a sequence, you can use a tail-away shot of a subject moving away from the camera. Shots, such as these, present moving images that increase or decrease in size and have more of an effect on apparent depth than do cross-screen movements.

Head-on and tail-away tracking shots add variety by offering a change from the usual three-quarter side shots. Head-on shots tend to produce greater audience impact because the audience is "placed" dead center with the action advancing toward them.

Constant Screen Direction

Constant screen direction shows subjects moving in one direction only. When one subject moves in the same direction through a series of shots, progression is represented.

Once screen direction has been established, it should be maintained until a change in direction can be explained. When a shot suddenly shows a subject traveling in the opposite direction to the previous shot, the audience will get the impression that the subject has turned around and is heading back to the starting point. Any change in screen direction must be explained.

One way to change screen direction (for example, a head-on to a tail-away) and explain the change to the viewers is to film the subject in the following sequence. First, record a head-on shot. Secondly, cut the shot to a three-quarter angle of the subject moving left to right. Next, cut the three-quarter angle to a view of the subject crossing the screen, then to a rear three-quarter angle of the subject. Finally, cut from the rear three-quarter angle to a tail-away shot (fig. 13-12).

A way to maintain constant screen direction is to use the action-axis technique. An action axis is nothing more than an imaginary line created by subject movement.

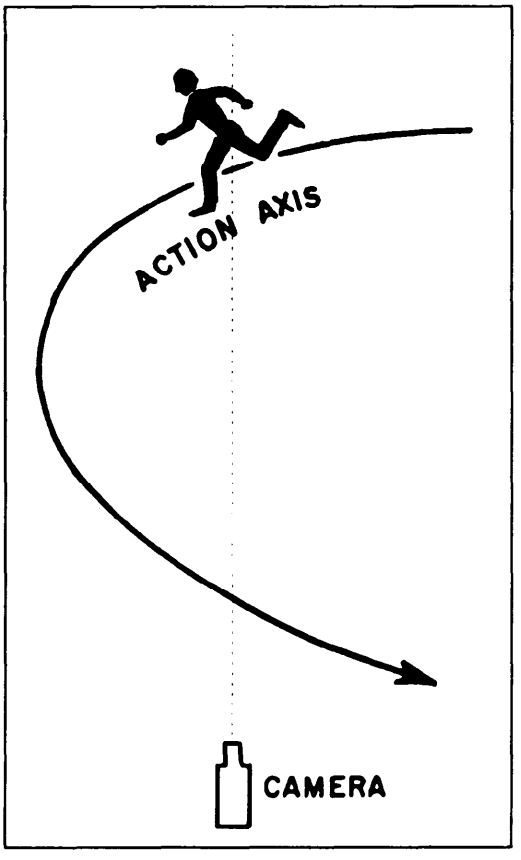


Figure 13-13.–Subject crossing the action axis.

When the camera is positioned on the same side of the action axis each time it is moved for a series of shots, the screen direction remains the same throughout the series. The relationship between the camera and subject movement or action axis remains the same if the camera does not cross the action axis. Once established, screen direction can be maintained by keeping the camera on the same side of the action axis.

When constant screen direction cannot be maintained, any change in direction MUST be visually explained to the audience. Constant screen direction changes can be explained in the following ways:

- Show the moving subject actually changing direction. This is the most effective way to change screen direction because the audience sees the subject change direction and there is no doubt in their minds how it took place.

- Film the moving subject crossing the action axis on a corner or curve. This permits the subject to exit the frame on the "wrong side," thus changing screen direction (fig. 13-13).

- Use a reaction closeup shot of an observer viewing the movement in the new direction. A reaction close-up serves as a neutral shot and distracts the audience, so the change in screen direction can take place. A reaction close-up, in this situation, could be a close-up of an observer's head turning to follow the movement of the previous scene. The head of the observer should turn as though the action is taking place behind the camera, thus putting the camera between the action and the observer.

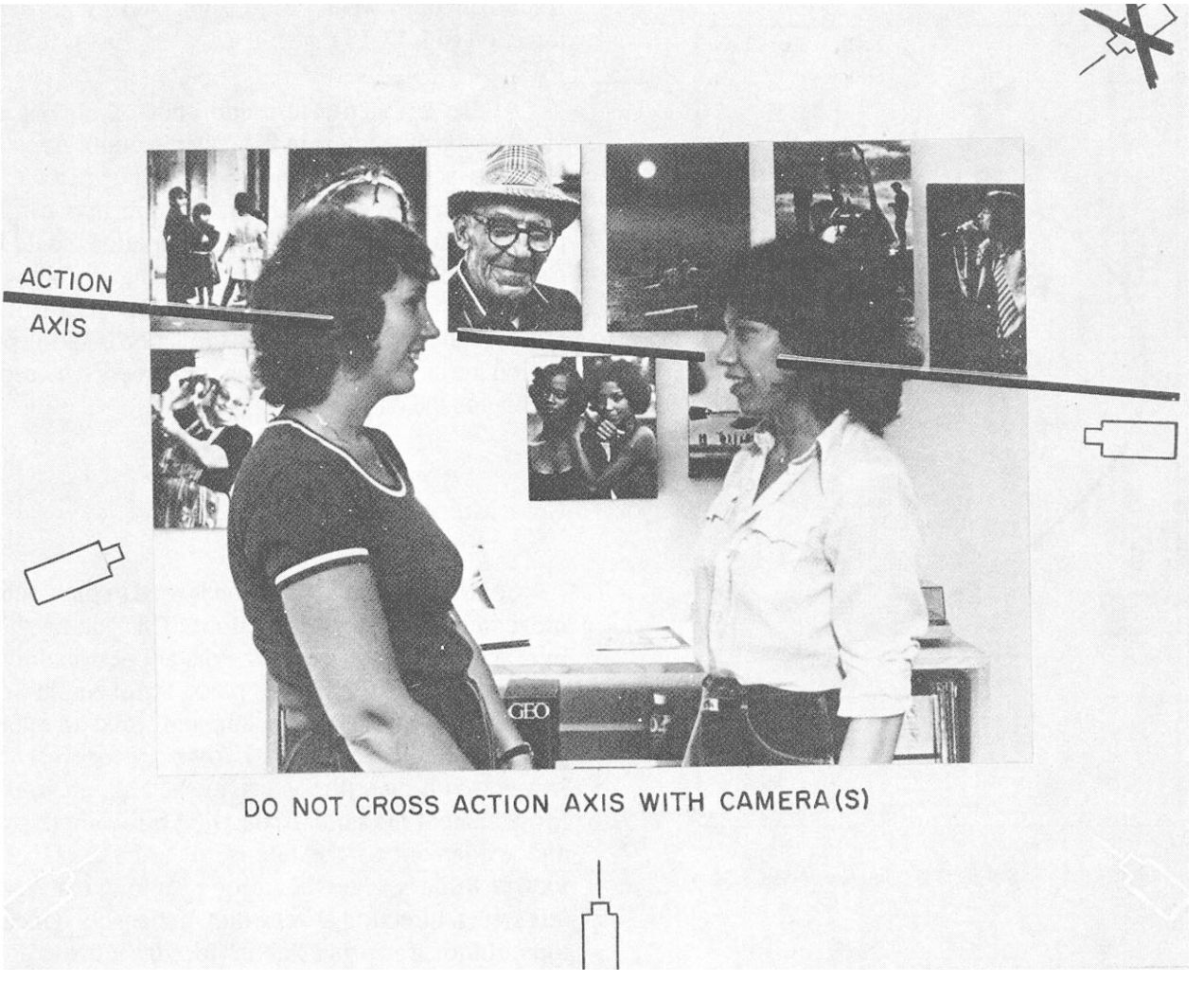
Contrasting Screen Direction

Contrasting screen direction is used to show subject movement in opposite directions. This can be shown by a subject moving toward a distant destination and then returning to the starting place. An example would be a sailor who leaves the ship and walks in a left to right screen direction to town. Therefore, the ship-to-town direction is established as left to right. Movement of the sailor to the right is toward the town and movement to the left is toward the ship. The viewer will associate the sailor's walking in a right to left screen direction as returning to the ship. Once the direction of travel is established, you must maintain it.

Contrasting screen direction is also used to show opposing subjects moving toward each other. An example would be two warships that are headed into battle. The first ship is shown steaming from left to right, and the second ship is shown steaming from right to left. This pattern gives viewers the impression that the ships are closing the distance between them and will soon meet.

Static Screen Direction

Static screen direction refers to the direction that subjects look or face. Screen direction must be established and maintained even when the subject does not move about within the scene. The direction in which the subject looks should match throughout a series of consecutive shots. The direction the subject faces can be different from the direction that the subject looks; therefore, the static screen direction is the direction in which the subject is looking. To maintain static screen



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Figure 13-14.–To maintain static screen direction, do not cross the action axis with a camera.

direction, the camera operator must remain on one side of the action axis (fig. 13-14).

CUT-IN AND CUTAWAY SHOTS

In filming uncontrolled action, it is almost impossible at times to film overlapping action. This is where cut shots come into play. Cut shots are extremely valuable because they provide a form of audience distraction In addition, the cutaway can account for lapses of time and stimulate audience interest; therefore, if you shoot plenty of cutaways and cut-ins, you have passed a major stumbling block in shooting uncontrolled action. Shooting a football game is a good example of uncontrolled action; but can you imagine how boring it would be if there were no cutaways or cut-ins? An audience would soon get tired of seeing nothing but football plays. By using different scenes, you can show just the highlights of the game and the audience will go away satisfied, feeling that they have seen the entire game.

Cut-ins and cutaways are related to the primary subject or action. They show something that may or may not have occurred simultaneously with the primary action. Both cut-ins and cutaways fill gaps between scenes where the action does not match. The use of cut-ins and cutaways can account for a lapse of time or they are used to create or enhance the mood of a film.

Cutaway shots are scenes that “cut” away from the action. Crowds, cheering fans, cheerleaders, and side-line action are all examples of cutaway shots. Ideally, cutaways should smooth out the continuity of the film, so the audience does not realize that some of the action that took place on the field has been removed from the film.

A cutaway also can be used when you want to condense an extended flow of action; for example, if you start a sequence with a closeup shot of the time clock indicating 12 minutes left in the quarter, then cut to the primary action on the field for about 10 seconds, then cut back to the clock indicating 3 minutes left-the elapsed time of 9 minutes would be indicated to the audience.

An example of a cut-in is a close-up of one player's foot as he kicks the ball. This close-up could have been shot at any time; however, by inserting the cut-in into the film during editing, the audience feels that the kick actually happened during the game.

The difference between a cut-in and a cutaway is simple. When filming the football game, the camera operator "went in" and took a close-up of the kicker's foot as he kicked the ball. The operator of the camera cut-in to the action. However, when the camera operator shoots a close-up of a fan's foot kicking another fan who had been rooting for the wrong team, that is a cutaway, because it cut away from the primary action of the game. Cutaway shots represent secondary action. Cut-in shots represent primary action.

CONTROLLED ACTION

As the name implies, in controlled action you can control all aspects of a production. This includes actors, their actions, the set lighting, and sound recording, if any. You usually work from a well-developed script that includes all the details. If the actors speak, the dialogue is in the script. If the action is described by a narrator, the narration is in the script. If the film is silent, the titles appear in the script. Examples of controlled-action films include training films, some documentaries and historical records, and many publicity or recruiting films. Controlled action, motion-media productions are produced only by personnel with specialized "C" school or university training. As a nonspecialized Photographer's Mate, you will be faced with uncontrolled or semicontrolled action elements of a production or film.

UNCONTROLLED ACTION

In a controlled-action situation, everything is normally written in the form of a detailed shooting script. Predictable filming is performed and there are few crises, except the occasional human oversights and mechanical malfunctions.

The other world of motion-video recording (uncontrolled action) is full of crises and surprises. Success primarily is due to good reflexes, accurate guesswork, and quick thinking. Careful planning is not the most significant factor. Most of your motion-media assignments will be uncontrolled or semicontrolled action.

Your success as a maker of uncontrolled-action films depends on your knowledge of the capabilities and operation of video equipment. You must also possess a high level of technical skill. There is neither time nor opportunity for research or practice while doing this kind of assignment. You must be prepared in advance. News, sports, special events, and on site-coverage of ongoing activities make up the bulk of this type of assignment. Another class of uncontrolled action is the documentation of events that follow a known course or pattern, such as parades and ceremonies. These are called semicontrolled, because you know in advance approximately what is going to happen, even though you cannot influence it for recording purposes. Both types of assignments are challenging, exciting, and usually welcomed by confident camerapersons. But, they can be "unfortunate experiences" for those not properly prepared to cope with them.

PREPARATION FOR FILMING UNCONTROLLED AND SEMICONTROLLED ACTIONS

Obviously you cannot develop a specific, detailed plan for shooting uncontrolled or semicontrolled action. You must get as much information about the assignment as possible and in as far in advance as possible. This information helps to provide an estimate of requirements for equipment, supplies, scheduling of personnel, transportation, camera positions, lighting, and other technical details.

Whenever you are assigned to cover VIP arrivals, award presentations, or special events, you should immediately contact the person or agency in charge of the project. This person is usually the public affairs officer (PAO). The PAO can furnish you the full scope of your assignment and provide the following basic information:

- Name and rank or title of the person(s) involved
- Place and time of arrival
- Complete schedule of activities

When possible, you should personally inspect the location and route of the proposed action (site survey). If this cannot be done, try to get drawings, maps, plans, or photographs of the area. Eyewitness descriptions or

pictures of similar events also may be helpful. Ask questions about the location of the subject, the type and direction of movement, and the sequence of actions to be recorded.

With this information, you can draft a rough plan. By working closely with the project officer, you should be kept reasonably well informed and can arrange your shooting in a logical order. Be careful, however, not to "plan yourself into a trap." Expect last minute changes in your plan, and, therefore, keep alternative plans in mind and ways they can be put into effect quickly.

Next, determine shooting requirements and the number of cameras and people you need. Check probable camera locations for the long, medium, and closeup shots. Determine the amount of tape you require, and consider the possibility of some unplanned requirements. Determine whether you will need transportation and additional equipment.

A hypothetical assignment: The lab has received the following orders: "The Chief of Naval Operations and his party are expected to arrive aboard your ship tomorrow. The flag requires complete photographic coverage of all official activities of the CNO and his party while on the ship." The division chief has assigned you to cover the motion media.

After you check with the officer in charge of the event, you find that the CNO and his party are expected to arrive by aircraft at 1300 hours. The party consists of the Chief of Naval Operations and three aides. The purpose of this visit is to inspect the ship and to present several awards. The CNO and his party plan to depart at 1700 the same day.

With this information you can now plan your shooting outline. In an event of this kind, you cannot expect to stage or control many shots.

The following shooting outline is an example of what you might come up with:

Scene 1: Aircraft (A/C) with CNO landing.

Scene 2: Side boys, flag officer, and CO on deck in front of island.

Scene 3: A/C taxies to island.

Scene 4: CNO's party disembarks A/C.

Scene 5: Flag officer and CO greet CNO.

Scene 6: CNO inspects side boys.

Scene 7: LS, MS, and CU of CNO presenting awards.

Scene 8: CNO makes speech

Scene 9: CNO and party tour ship.

Scene 10: CNO and party return to A/C.

Scene 11: A/C taxies to fantail for deck launch.

Scene 12: A/C takes off.

Now, how do you get the coverage?

In scene 1, you could be in a high position for an establishing shot showing the flight deck with the A/C landing. After the A/C lands, you move down to the flight deck and shoot scene 2, MS, of the side boys, the flag officer, and the CO taking their positions on deck to greet the CNO. Scene 3 is an LS showing the A/C taxiing to the island. For scene 4, shoot an MS of the CNO and his party leaving the A/C. Scene 5 is a CU of the flag officer and CO greeting the CNO. Scene 6 starts with an LS of the CNO inspecting the side boys. Circumstances permitting, move in for an MS and CU of the inspection. Scenes 7 and 8 should be easy to shoot because of the time it takes to read citations, make awards, and give a speech. This should allow plenty of time for you to move about and get long shots, medium shots, close-ups, and cut shots. Follow your judgment and intuition for shooting scenes 9, 10, and 11. Scene 12 is your closing shot. Again, shoot from a high position to show the flight deck. Pan the A/C and follow it until it is out of sight.

The shooting outline not only serves as a "program" for planning the sequence of coverage, but it also provides a basis for determining camera placement, movement, and shot framing.

RECORDING GRAPHICS

Graphics have many applications, such as title cards, cast lists, maps, tables, charts, photographs, and inserts. Graphics should not be treated casually. Without precautions, graphics can become unsharp, confusing, tilted, distorted, and incomplete. Much of the graphics and text used in motion-video productions are created on a character generator. A character generator is an electronic device used to create words or graphics and electronically inserts them over a video picture. When a character generator is not available, graphics must be recorded by a camera

When you are shooting graphics that will be viewed on a monitor, the camera lens must be centered and parallel the graphic. The graphic and camera must be level. Your framing must be correct.

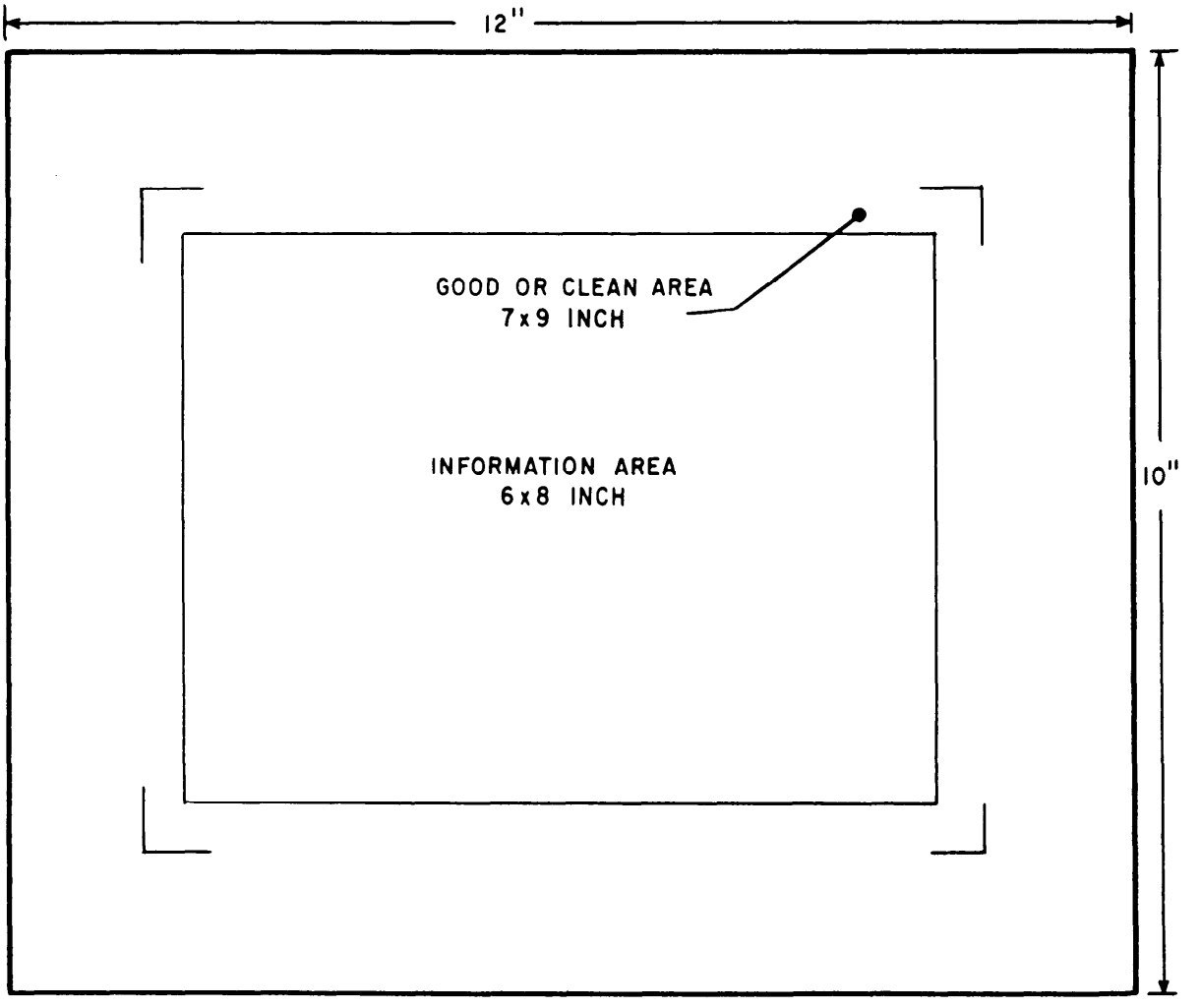


Figure 13-15.–The 3:4 ratio used for a video graphic.

Get in close enough with the video camera to show clearly all detail, but not so close that some of the information area is lost. Avoid using a wide-angle lens. Besides the possibility of camera shadows falling on the graphic, distortion is likely to occur and will be most noticeable when panning over the graphic. A longer focal-length lens overcomes the distortion problem, but is less smoothly panned.

LIGHTING

Because light reflections can obscure detail on a shiny graphic, the experienced graphic artist and photographer will avoid glossy materials and glossy photographs. However, when it is causing objectionable reflections, the graphic can sometimes be tilted slightly to help clear them; otherwise, relighting or surface dulling may become necessary. The lighting for a TV graphic is similar to lighting reflection originals in copy work. Graphics must be flat. Unmounted, warped, or curved surfaces easily show unwanted reflections.

SAFE TITLE AREA

In the production of slides for use as television graphics, important picture information must be confined within the area of the TV monitor.

Figure 13-15 is drawn in proportion to a 35mm film frame and shows the safe title area, maximum transmitted area, and film frame.

IDENTIFYING RECORDED IMAGE CONTENT

If you were notified that you won a brand new Jaguar or Lamborgini, you would probably be ecstatic. If you were presented with a truckload of unidentified, assorted parts and told that you now had everything

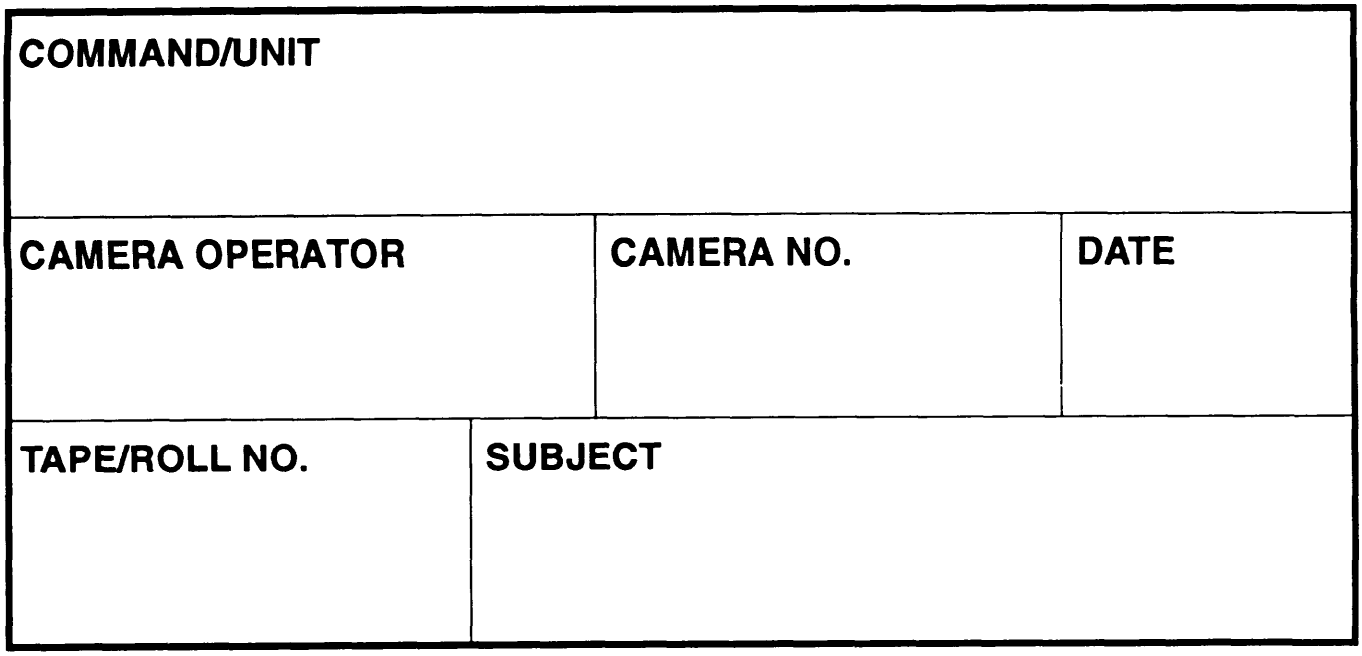


Figure 13-16.–The slate.

required to put the new car together, you probably would not be entirely grateful. Maybe you could assemble it (if you were an experienced mechanic), but you know that more information would save you time, frustration, duplication of effort, and help tremendously toward a successful outcome. On the other hand, if every part were clearly identified and the exact relationship to every other part was unmistakably described, you would certainly appreciate the gift much more. Being faced with several thousand feet of unidentified videotape is very much the same kind of situation.

The biggest problem encountered by imaging personnel in the Department of Defense during Operation Desert Storm was the lack of identification of exposed imagery. There were literally boxes of film and videotape lining the passageways in the Pentagon. Most of this imagery was of little value because it was not identified, or it was labeled inaccurately.

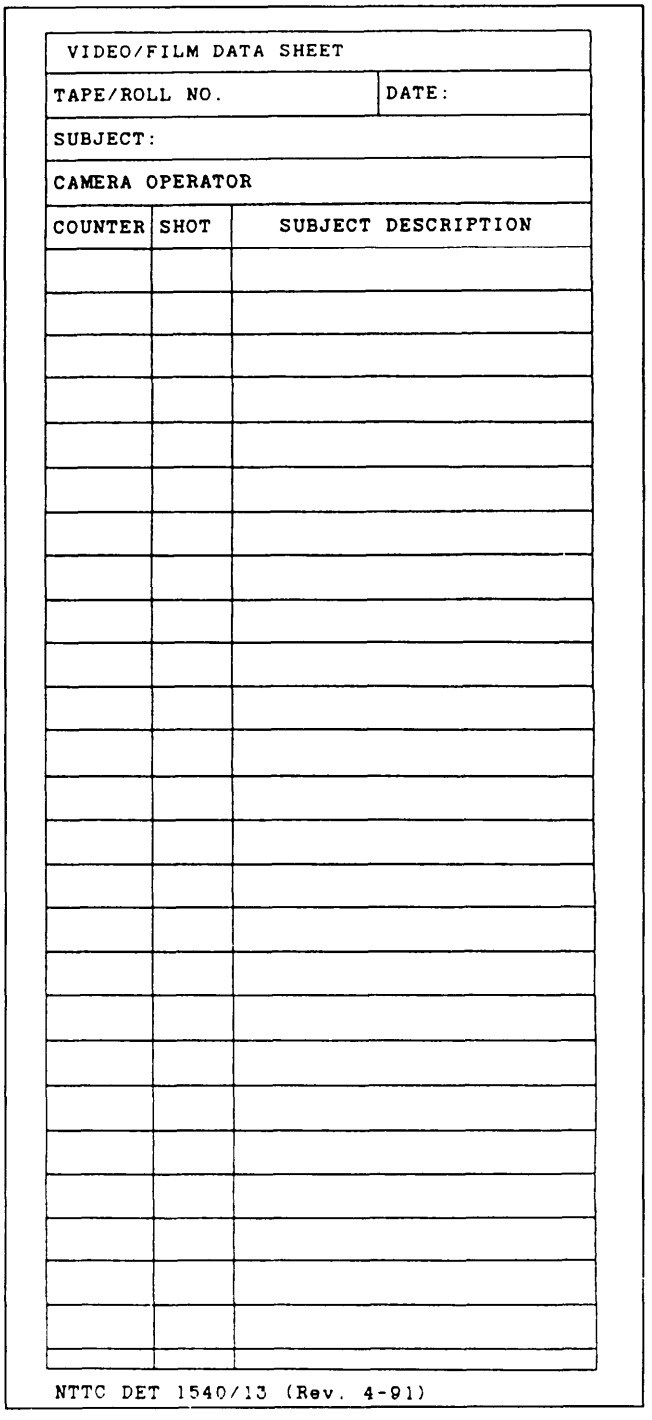
Accurate records are almost as important as good video coverage in achieving a professional product. Imaging products must be labeled, so the subject matter and subject location are easily identifiable on the tape. Often, there is no opportunity for personal contact between the cameraperson and editor; therefore, records identifying the filmed image content are the only information available. Logically, the better the records, the more useful the videotape. The opposite rule is also true. Inaccurate records can make the video coverage useless. Do not let that happen to your work.

SLATING

The slate you use to identify video scenes may take several forms. In emergencies you may even write scene identification on a scrap of paper and film it before shooting the scene; however, in most instances, your slate is more formal. Your regular slate is made to show whatever information is necessary. Generally, this includes the command or unit, title or subject, name of the cameraperson (identifies who is responsible for filming or videotaping the good or bad footage), date, location, and camera serial number (fig. 13-16). If you are part of a large organization that has several crews, then also include the unit number. In short, the slate should contain information needed for proper identification of each scene on your film.

The slate may actually be a piece of slate with the data written or lettered on it in white chalk. Quite often the "slate" is white with an acetate surface, and the data is written on it with a black grease pencil. When you slate a scene, hold the slate in front of the camera lens and record it for about 10 seconds for videotape or 3 feet for motion-picture film.

Of the information you place on your slate should be clearly printed in large, block letters. Film your slate so it fills the complete frame. If your slate is not full frame, the lettering may be too small to read when the tape is viewed.



VIDEO/FILM DATA SHEET

TAPE/ROLL NO.	DATE:
SUBJECT:	
CAMERA OPERATOR	

COUNTER	SHOT	SUBJECT DESCRIPTION

NTTC DET 1540/13 (Rev. 4-91)

Figure 13-17.–Video/Film Data Sheet.

If you do not have time to film the slate at the beginning of the scene, do it at the end of the scene. This is known as tail slating. Record the slate upside down, then rotate it right side up when tail slating. This shows that a tail slate was used; otherwise, the viewer might assume that it is associated with the scene following it on the tape. When recording without a script, you have no scene numbers to slate for each scene; therefore, for identification purposes, you slate only at the beginning of each tape. If for some reason you cannot slate at the beginning, tail slating applies.

Although you, the camera operator, do not derive any particular value from the slate, the person editing your film becomes frustrated, if not completely lost, when slates are not included. This is particularly true when your scenes are not shot in the same order as the script is written. The task of locating individual shots is almost impossible unless each scene is slated when it is originally filmed. You can understand now why you must slate each scene when shooting from a script.

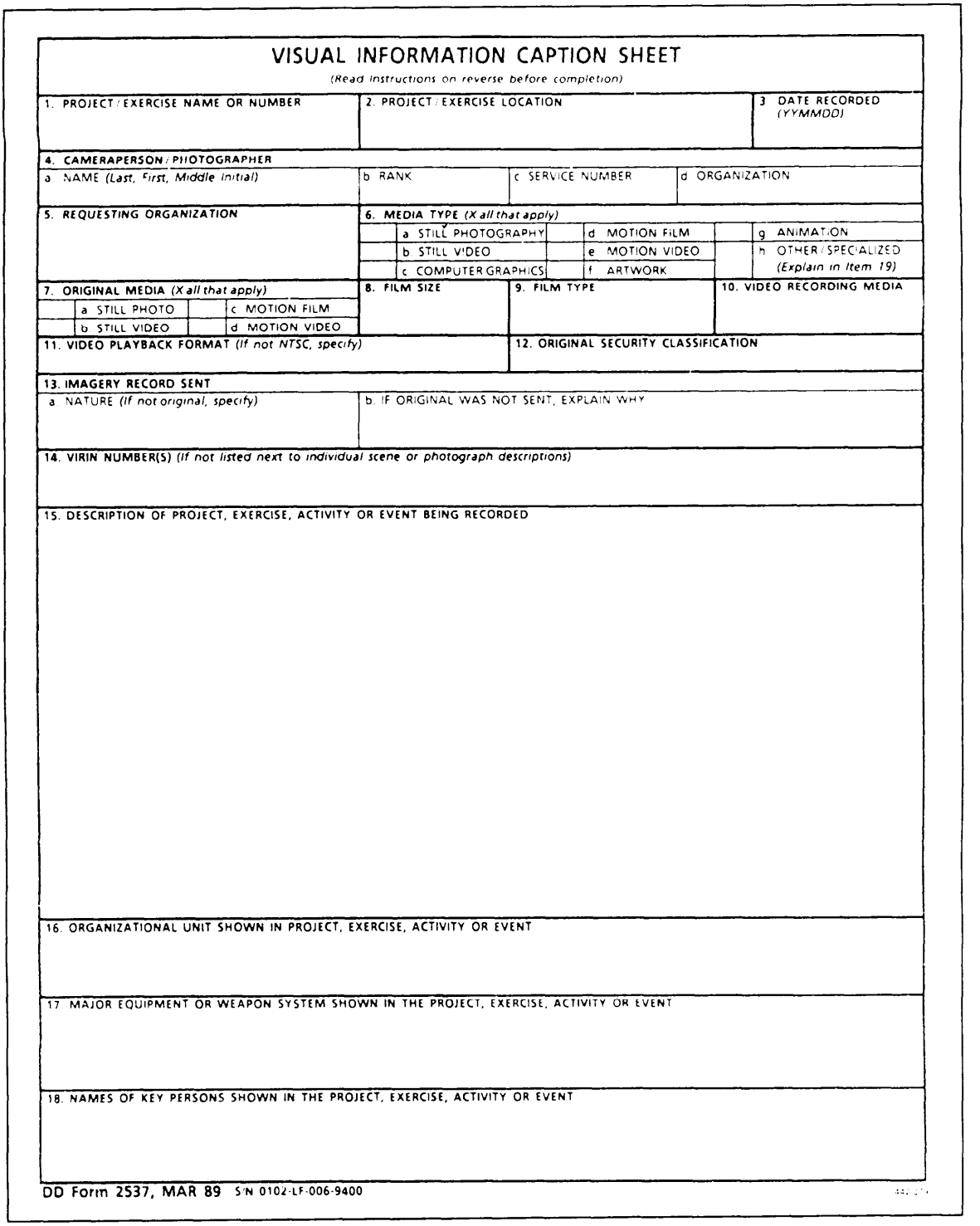
VIDEO/FILM DATA SHEET

Video/film data sheets are valuable to you (fig. 13-17). By looking at them you can tell the scenes that have been shot and those that still need to be done. Their main value, however, is to the editor. Without data sheets, the editor does not know the order in which the scenes were shot. Notice how the slate and data sheets work hand in hand. For a large project, the editor can check the data sheets and find a particular tape or scene easily. By screening just one videotape, the editor can spot the scene by checking the slate images. Imagine looking for a particular scene, at random, when it could be anywhere in a dozen or more tapes. Many hours are wasted when your data sheets are not properly prepared. The data sheet also may prevent accidental use of the wrong footage. If a scene was refilmed to correct an error, both the rejected and corrected versions of the same scene can be identified.

VISUAL INFORMATION CAPTION SHEETS

A Visual Information Caption Sheet, DD Form 2537, must accompany all products forwarded to a Still and Motion Media Records Center. The use of a visual information caption sheet ensures that all necessary caption information is available and standardized so it can be entered into computer data bases at the records center.

The instructions necessary to complete DD Form 2537 are printed on the back of the form. Because the completed form provides the cover story for the motion video product, it is important for you to provide accurate



VISUAL INFORMATION CAPTION SHEET

(Read instructions on reverse before completion)

1. PROJECT / EXERCISE NAME OR NUMBER	2. PROJECT / EXERCISE LOCATION	3 DATE RECORDED (YYMMDD)

4. CAMERAPERSON / PHOTOGRAPHER			
a NAME (Last, First, Middle Initial)	b RANK	c SERVICE NUMBER	d ORGANIZATION

5. REQUESTING ORGANIZATION	6. MEDIA TYPE (X all that apply)					
		a STILL PHOTOGRAPHY		d MOTION FILM		g ANIMATION
		b STILL VIDEO		e MOTION VIDEO		h OTHER / SPECIALIZED (Explain in Item 19)
		c COMPUTER GRAPHICS		f ARTWORK		

7. ORIGINAL MEDIA (X all that apply)				8. FILM SIZE	9. FILM TYPE	10. VIDEO RECORDING MEDIA
	a STILL PHOTO		c MOTION FILM			
	b STILL VIDEO		d MOTION VIDEO			

11. VIDEO PLAYBACK FORMAT (If not NTSC, specify)	12. ORIGINAL SECURITY CLASSIFICATION

13. IMAGERY RECORD SENT	
a NATURE (If not original, specify)	b. IF ORIGINAL WAS NOT SENT, EXPLAIN WHY

14. VIRIN NUMBER(S) (If not listed next to individual scene or photograph descriptions)

15. DESCRIPTION OF PROJECT, EXERCISE, ACTIVITY OR EVENT BEING RECORDED

16. ORGANIZATIONAL UNIT SHOWN IN PROJECT, EXERCISE, ACTIVITY OR EVENT

17. MAJOR EQUIPMENT OR WEAPON SYSTEM SHOWN IN THE PROJECT, EXERCISE, ACTIVITY OR EVENT

18. NAMES OF KEY PERSONS SHOWN IN THE PROJECT, EXERCISE, ACTIVITY OR EVENT

DD Form 2537, MAR 89 S/N 0102-LF-006-9400

Figure 13-l8A.–Visual information caption sheet (front).

information and as much detail as possible about the recorded event (fig. 13-18).

VIDEOTAPE CARE

The performance of videotape is often directly related to the care and proper maintenance it has or has not received. Temperature extremes should be avoided when storing tape between recording and playback. Wide temperature variations can result in a tremendous amount of stress on the innermost tape layers caused by dimensional changes. If a tape has been in storage at sub-zero temperatures, for example, you must

19. CAPTION DESCRIPTION OF PHOTOGRAPH(S) OR SCENE(S) *(List who, what, when, where, why and how)*

20. COPYRIGHT OR OTHER RIGHTS IDENTIFICATION *(If applicable)*

INSTRUCTIONS

Items not listed are self-explanatory.

ITEM

2 Enter the location where the photographs / film/ video described on this caption sheet were taken.

5 Enter the organization which requested the imagery.

6 Describe media being forwarded to VI Records Center by entering an "X" in the appropriate box or boxes. If 6.h is marked, explain in Item 19.

7 Describe medium in which imagery was originally recorded.

8 Enter specific film size, e.g. 16mm, 35mm, 4x5, etc.

9 Enter specific film type, e.g. Kodachrome 64, Ektachrome 200, Plus-X, etc.

10 Specify whether 1", 3/4", VHS, Betacam, M-II, 8mm, etc.

11 Specify if PAL, SECAM, HDTV, etc.

ITEM

13 If not original imagery, list specific type such as copy negative, duplicate negative, video dub, etc.

15 This is the cover story. Give a complete description of the project, exercise, activity, or event being recorded. Provide as much detail as possible.

16 Provide the unit designation and its home location.

17 Describe the major equipment items or weapon system shown. For example, if there is a photograph or video segment showing A-10s flying over M-1 tanks, enter "A-10 aircraft and M-1 tanks" in this item.

18 Include the full name, rank, and position of each person pictured unless all of the above information is included elsewhere on the form and it is indicated which descriptions apply to which scenes or photographs.

21. FOR USE BY RECORDS CENTER

a RECORD ACCESSION DATE *(YYMMDD)*	b. PRESENT SECURITY CLASSIFICATION *(If different from original)*	c FINDING AID KEYWORDS *(Using revised DAVIS Thesaurus)*

DD Form 2537 Reverse, MAR 89

Figure 13-18B.–Visual information caption sheet (back).

"condition" it to room temperature. Complete dimensional equilibrium may take as much as about 16 hours. Never use direct heat to speed up the conditioning process. High temperatures can create harmful differences in layer-to-layer tension on the reel. Never use extreme cold, such as a freezer, to cool down a hot tape. In general, recommended storage conditions for videotapes are as follows:

Relative Humidity . . . . . 50% - 60%

Temperature . . . . . 60°F - 80°F

For best long-term storage, rewind video cassettes uniformly for even tension before boxing. Tapes should always be in one of two places-in the VTR or in the original box. Stand videotape boxes upright. Do not store tapes in a horizontal position. This can cause bending and distorting of reel flanges that can be a major cause of tape edge damage.

To prevent damage, you should protect videotapes by covering them when they are not in use. Keeping them in dustproof cassette containers prevents the accumulation of airborne dust on the tapes. Dust can be a prime cause of dropout. Body oils and salts from your fingertips can pick up and hold foreign particles that, when transferred to the tape, cause dropouts.

CHAPTER 14

JOB CONTROL AND PHOTOGRAPHIC FINISHING

No job is finished until the paper work is complete. This statement holds true for all photographic jobs completed in your imaging facility. In order for your imaging facility to operate efficiently, you must follow the procedures that regulate job control and other administrative procedures within your facility. This chapter is intended as an introduction only. A more in-depth understanding of Navy imaging administrative procedures are found in *the Navy Visual Information Management and Operations Manual,* OPNAVINST 5290.1 (series).

The first topic discussed in this chapter is the handling of classified material. You must learn to follow strict guidelines when handling classified material. There is no allowance for mistakes. Become thoroughIy familiar with the standard operating procedures established in your imaging facility.

SAFEGUARDING CLASSIFIED MATERIAL

Modern methods of conducting war and safeguarding our nation require a tremendous amount of information. This information is stored in books and files, it accumulates in reports, it is gathered by intelligence activities, and it is transferred in the form of letters, messages, photographs, and audio and video recordings. This information is sifted and organized in the minds of the people directing the war effort and those keeping the peace. Much of this information is extremely valuable to our enemies, and, therefore, must be classified and safeguarded in the interest of national security.

In performing your job as a Navy Photographer's Mate, you may have access to classified information. Therefore, you MUST become aware of the importance of safeguarding all classified information to which you have access.

Classification categories, procedures, and related-security information pertaining to the Navy are contained in the *Department of the Navy Information and Security Program Regulation,* OPNAVINST 5510.1 (series). A copy of this regulation is available in every Navy imaging facility where classified information is maintained or handled. Refer to this regulation frequently to make sure you safeguard properly classified material. Never depend on your memory regarding the proper disposition of classified information, particularly if you handle it infrequently.

The purpose of the security program is to protect classified material from unauthorized disclosure. It is the responsibility of all military personnel to safeguard classified information.

The Navy controls the dissemination of classified information. Therefore, knowledge or possession of classified information is permitted only to those persons who actually require it in the performance of their duties. This principle is referred to as the "need to know" and is a prerequisite for access to classified information. Access to classified material is not automatically granted because a person has the proper clearance, holds a particular billet, or is sufficiently senior in authority. Access is granted only if the criteria of proper clearance and "need to know" are both met.

Official material that requires protection in the interest of national defense is categorized in three designations. These three designations, in descending order of importance, are Top Secret, Secret, and Confidential. No other designation is used to classify defense matters that require protection in the interest of national defense.

TOP SECRET

The classification "Top Secret" is limited to defense information or material that requires the highest degree of protection. The Top Secret classification is applied only to information or material that is paramount to national security and the unauthorized disclosure of which could reasonably be expected to cause exceptionally grave damage to the national security.

SECRET

Material classified as "Secret" is limited to defense information or material. The unauthorized disclosure of

which could reasonably be expected to cause serious damage to the national security.

CONFIDENTIAL

Use of the classification "Confidential" is limited to national defense information or material, the unauthorized disclosure of which could reasonably be expected to cause damage to national security.

RESTRICTED DATA

The term *Restricted Data* as defined in the Atomic Energy Act of 1954 means all data concerning (1) the design, manufacture, or utilization of atomic weapons; (2) the production of special nuclear material; or (3) the use of special nuclear material in the production of energy.

The term *Formerly Restricted Data* applies to classified defense information which (a) has been removed from the Restricted Data category in order to conform with the Atomic Energy Act of 1954 and (b) cannot be released to foreign nationals except under specific international agreements.

Restricted Data and Formerly Restricted Data are NOT in themselves classification categories, but are additional warning notices of special handling requirements. Thus a classification category is used with the warning notice wherever it is appropriate.

FOR OFFICIAL USE ONLY

The designation "For Official Use Only" is assigned to official information that requires protection according to statutory requirements or in the public interest, but does not require safeguarding in the interest of national defense.

A security classification may not be used to conceal violations of law, inefficiency, or administrative error; to prevent embarrassment to a person, organization, or agency; or to restrain competition.

AUTHORITY TO CLASSIFY

The authority to assign a security classification is restricted to those officials who have been designated the authority in writing.

Original Classification

One important aspect of classification that is commonly misunderstood is the difference between original and derivative classification. Original classification is warranted only when information requiring classification is generated and classification cannot be derived from information that was classified previously. For example, information pertaining to a technological breakthrough or a significant scientific advance generally requires original classification authority.

Derivative Classification

The majority of classified material you work with is the product of derivative classification. As the word implies, this type of classification is based on and obtained from a previous classification. Derivative classification is applied when the information presented is the same (or closely related to) as other information that already is assigned a classification.

Suppose you are making photographs for a report of Iraqi warships in the South China Sea If the report is based on a source document that states that such photographs should be classified, your classification is derived from that source. Or suppose you take pictures of a radar system that is classified Secret. Then the picture, the negatives, the test prints, and the enlargements are also classified Secret. The classification of the pictures is derived from the classification of the radar system. Most of the information classified derivatively is taken from documents classified previously. Whenever you copy or extract classified information, you must ensure that the extracted information bears the same classification in the new document (such as a photograph) as it did in the source document.

In marking a derivatively classified document, you must cite the source of that classification or authority (e.g., CNO ltr, ser OP-009 of 1 Oct 93) on the "classified by" line. Records must be available for the lifetime of the document to show the basis for classification or to trace the chain of classification authority.

CLASSIFICATION MARKINGS ON IMAGING PRODUCTS

The requester of imaging products determines the security classification of the product according to the guidelines contained in OPNAVINST 5510.1. Each original and all photographic copies that are classified must be marked with the appropriate security classification, the classification authority, and declassification and downgrading instructions based on the original classification markings.

Photographic film, prints, and slides that are classified must be marked with the appropriate classification and other applicable markings.

Film

Roll negatives are marked on the base side with the classification and associated markings at the beginning and end of each strip. Single negatives cut from the roll or single- sheet film negatives must also be appropriately marked on the base side. These materials must be kept in envelopes or film canisters with conspicuous markings.

Transparencies and Slides

The classification and associated markings must be shown clearly on the slide mount or transparency frame and whenever possible on the image area. Because the classification on 35mm slides are not conspicuous until they are projected, the classification must be marked on the slide mount. It is not necessary for each transparency of a set of transparencies to bear applicable associated markings when the set is controlled as a single document. In such cases, the first transparency bears the applicable associated markings.

A camera that contains exposed film of a classified subject must be given the same protection as the classified subject. Be cautious with Polaroid film when photographing classified material. All waste products produced by these films must be destroyed as classified waste.

Prints

All 8x10 and larger prints must be marked with the classification at the top and bottom of the face side with the associated markings at the bottom. On smaller prints the classification is required to appear only once on the face side. When it is not practical to place the classification and associated markings on the face side of prints, the markings can be placed on the reverse side, using a pressure tape label or a stapled strip when stamping is not practical. All photographic reproductions must show the classification and associated markings clearly.

Motion-Media Products

The beginning of each reel of film or videotape must be marked with a title that bears the classification and associated markings. These markings must be visible when projected on the screen or played through a monitor. Only the overall classification is required at the end of the reel or videotape. Reels and cassettes must be marked with the appropriate classification and kept in containers that are marked conspicuously with the classification and associated markings.

DISCLOSURE OF CLASSIFIED MATERIAL

When classified matter is entrusted or made known to you, you must protect it against loss or compromise. You are responsible for any act or failure that contributes to the loss, compromise, or unauthorized disclosure of classified information. This includes information that is passed verbally.

When you are found responsible for the loss, compromise, or unauthorized disclosure of classified matter or when you violate security regulations, you can expect to be disciplined promptly. Disciplinary action may include, in the case of military personnel, trial by court-martial or, in the case of civilians, prosecution under Title 18, United States Code, as amended, or other federal statutes, as appropriate.

PROTECTIVE MEASURES

Generally, there are four ways that classified information is protected: censorship, physical security, transmission security, and cryptographic security. As a photographer, you will be concerned primarily with personal censorship and physical security.

Personal Censorship

Censorship places a barrier between classified information and unauthorized personnel by preventing disclosure in the form of letters, conversations, and personal contacts. Restricting information at the source, except for official use, depends on the integrity and discretion of the individual.

Physical security

Physical security is the safeguarding of documents, photographs, and other items that contain classified information. Later in this chapter, another form of physical security used to safeguard property and material physically at Navy shore activities is discussed.

Physical security is the concern for protecting classified documents, devices, and materials, so they never fall into the hands of unauthorized personnel or come within optical range of actual or possible enemies. When working with classified matter, you must protect it from being seen by unauthorized individuals, either military or civilian. No person should have access to classified material unless it is necessary for them to carry out their official duties. Classified material must never be removed from its designated working space or left unguarded. When not actually in use, you must keep it locked up in an authorized container.

DESTRUCTION OF CLASSIFIED MATERIALS

When classified products, such as photographs, videotapes, or audio recordings, are no longer needed or useful, they must be destroyed. The products must never be discarded in ordinary containers.

Destruction of classified material must be accomplished and witnessed by persons who are cleared to the level of the material being destroyed. A record of destruction is mandatory even when an originator states in a document that it "may be destroyed without report." This statement means only that the originator does not need to be notified of the destruction.

A record of destruction is required for Top Secret and Secret material, but not for Confidential material. Destruction may be recorded on OPNAV 5511/12 (Classified Material Destruction Report) or on any other record that includes complete identification of the material, number of copies destroyed, and the date of destruction. The record of destruction must be signed by the two cleared people involved in the destruction of Top Secret materials, and the record must be retained for 2 years.

Classified documents can be destroyed by burning, pulping, pulverizing, or shredding. When destruction is accomplished by means other than shredding, the residue must be inspected to ensure complete mutilation.

In most imaging facilities, the policy is to give all scrap materials, test prints, and any other material generated from a classified job, back to the requester. Do not destroy classified materials without first consulting your supervisor.

SECURITY AREAS

Spaces that contain classified matter are known as security (sensitive) areas. The areas have varying degrees of security, depending on their purpose, the nature of the work, and the information and materials involved. All security areas should be clearly marked by signs marked Restricted Area. Three types of security areas are established to meet different levels of security sensitivity.

Exclusion Area

Spaces requiring the strictest control of access are designated exclusion areas. They contain classified matter that restrict admittance to only those persons that require access to the materials and have a "need to know."

An exclusion area is fully enclosed by a perimeter barrier. All entrances and exits are guarded, and only those persons whose duties require access and have the appropriate security clearance are authorized to enter.

Limited Area

A limited area is one where the uncontrolled movement of personnel permits access to classified information. Within the area, access may be prevented by escort and other internal controls.

The limited area is enclosed by a clearly defined perimeter barrier. Entrances and exits are guarded or controlled by attendants to check personal identification. These areas also may be protected by an automatic alarm.

Most Navy imaging facilities should be considered at least a limited area when classified work is in progress. All visitors must be escorted within these spaces. When classified work is in progress, it should be excluded from all personnel who do not have the need to know. Even when classified work is not in progress, it is wise to operate within your imaging facility as though it was a limited area because there is a considerable amount of expensive equipment throughout.

Controlled Area

A controlled area usually does not contain classified information. It serves as a buffer zone to provide greater administrative control, safety, and protection for the limited or exclusion areas. These areas require personnel identification and control systems to limit admittance to those people having bona fide need for access to the area

Passageways or spaces surrounding or adjacent to limited or exclusion areas may be designated as controlled areas.

SAFEKEEPING AND STORAGE OF CLASSIFIED MATERIAL

Classified information or material must be stored under conditions that prevent unauthorized persons from gaining access to it. The security requirements must allow work to be accomplished while providing adequate security. In the Navy, the commanding officer is directly responsible for safeguarding all classified information within his command. He is also responsible to ensure that classified material is stored properly when not actually in use.

Storage

Whenever classified material is not under the personal control and observation of an authorized person, it must be guarded or stored in a locked security container.

Top Secret material is stored in a safe or safe type of steel file container having a three-position combination lock as approved by the General Services Administration (GSA) or a class A vault that meets the standards established by the Director of Naval Intelligence. An alarm-protected area may be used to protect Top Secret material when the responsible local official decides that an alarm system provides protection equal to, or better than, the safe, steel file, or vault. The alarm-protected area provides a physical barrier that prevents removal of the material and prevents the material from being viewed by unauthorized personnel and compromised.

Secret and Confidential material may be stored in the same manner authorized for Top Secret or, in a class B vault, a vault type of room, or a secure storage room that has been approved according to the standards prescribed by the Director of Naval Intelligence.

Valuables, such as money, jewels, precious metals, narcotics, and so forth, should not be held in safes used to store classified materials because they increase the risk of theft. Only classified materials are to be placed in containers designated for storage of classified material.

Container Designations and Combinations

Containers used for the storage of classified material are assigned a number or symbol for identification purposes. The identifying numbers or symbols are located in an obvious location on the outside of the container. Each container must also meet the security requirements for the highest classification of material stored in the container. However, this designation is not marked externally on the container.

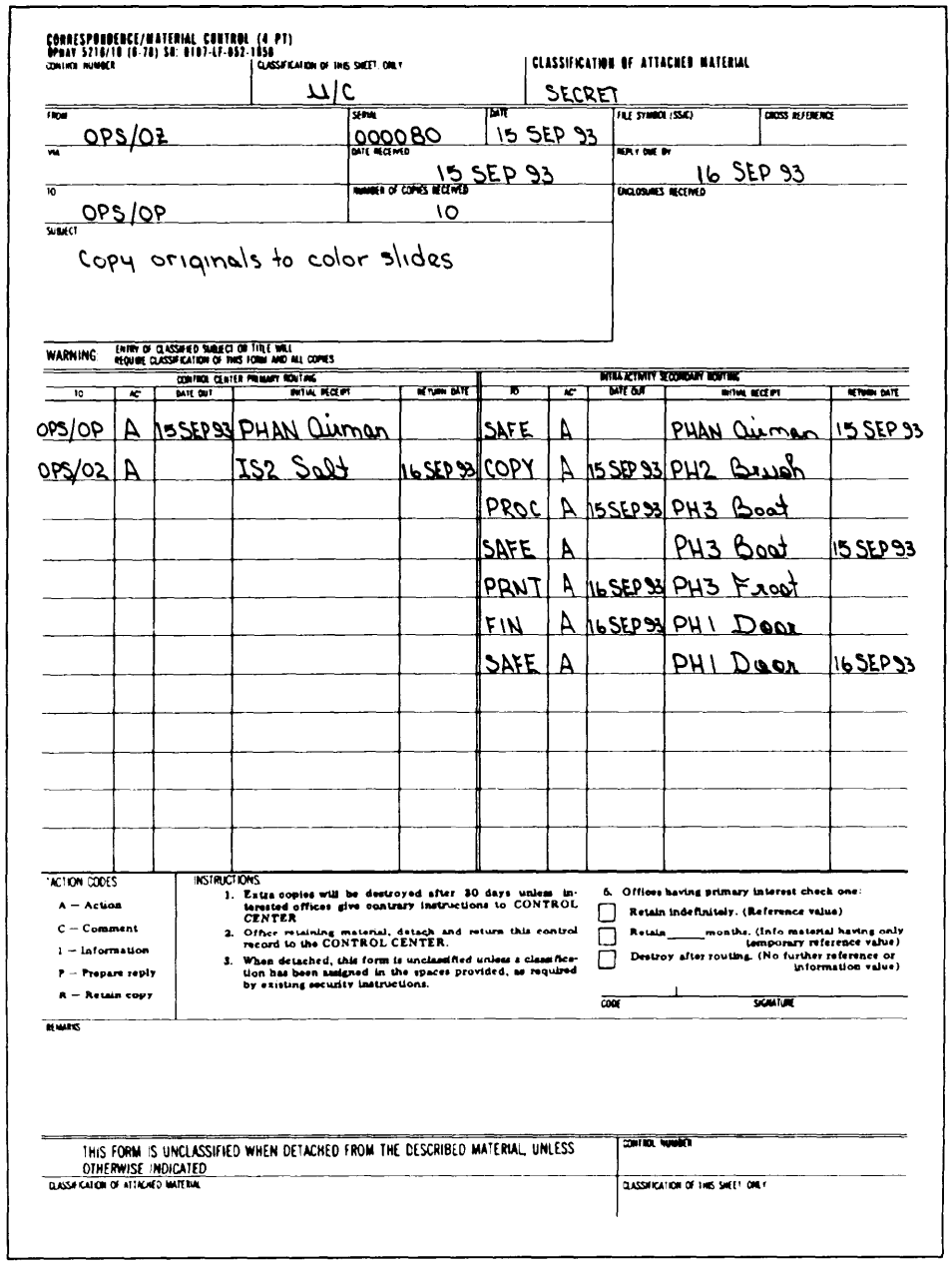
Records of combinations are sealed in envelopes (OPNAV 5511/2) and kept by the security manager, duty officer, communications officer, or other person(s) designated by the commanding officer. Combinations for containers with noncryptographic material will be changed under any of the following conditions:

- When a safe is first placed into use
- Annually
- When the combination or record of combinations has been compromised or a security container is discovered unlocked and unattended
- Whenever an individual knowing the combination is transferred or discharged, or when the security clearance of an individual knowing the combination is reduced, suspended, or revoked

When you are selecting new combination numbers, multiples of 5, simple ascending or descending numerical series, and personal data (such as birthdays and serial numbers) must not be used. The same combination cannot be used for more than one container.

Combinations to security containers are changed only by persons that are cleared for the highest level of classified material stored in the container.

When a security container is taken out of service, built-in combination locks must be reset to the standard combination 50-25-50. Combination padlocks must be reset to 10-20-30.



CORRESPONDENCE/MATERIAL CONTROL (4 PT)
OPNAV 5216/10 (8-78) SN: 0107-LF-052-1650

CONTROL NUMBER | CLASSIFICATION OF THIS SHEET ONLY: U/C | CLASSIFICATION OF ATTACHED MATERIAL: SECRET

FROM: OPS/02 | SERIAL: 000080 | DATE: 15 SEP 93 | FILE SYMBOL (SSIC) | CROSS REFERENCE

VIA | DATE RECEIVED: 15 SEP 93 | REPLY DUE BY: 16 SEP 93

TO: OPS/OP | NUMBER OF COPIES RECEIVED: 10 | ENCLOSURES RECEIVED

SUBJECT: Copy originals to color slides

WARNING: ENTRY OF CLASSIFIED SUBJECT OR TITLE WILL REQUIRE CLASSIFICATION OF THIS FORM AND ALL COPIES

CONTROL CENTER PRIMARY ROUTING					INTRA-ACTIVITY SECONDARY ROUTING				
TO	AC	DATE OUT	INITIAL RECEIPT	RETURN DATE	TO	AC	DATE OUT	INITIAL RECEIPT	RETURN DATE
OPS/OP	A	15SEP93	PHAN Qiuman		SAFE	A		PHAN Qiuman	15 SEP 93
OPS/02	A		IS2 Solly	16SEP93	COPY	A	15SEP93	PH2 Brush	
					PROC	A	15SEP93	PH3 Boat	
					SAFE	A		PH3 Boat	15SEP93
					PRNT	A	16SEP93	PH3 Frost	
					FIN	A	16SEP93	PH1 Door	
					SAFE	A		PH1 Door	16SEP93

ACTION CODES
A — Action
C — Comment
I — Information
P — Prepare reply
R — Retain copy

INSTRUCTIONS
1. Extra copies will be destroyed after 30 days unless interested offices give contrary instructions to CONTROL CENTER.
2. Office retaining material, detach and return this control record to the CONTROL CENTER.
3. When detached, this form is unclassified unless a classification has been assigned in the spaces provided, as required by existing security instructions.

6. Offices having primary interest check one:
☐ Retain indefinitely. (Reference value)
☐ Retain _____ months. (Info material having only temporary reference value)
☐ Destroy after routing. (No further reference or information value)

CODE | SIGNATURE

REMARKS

THIS FORM IS UNCLASSIFIED WHEN DETACHED FROM THE DESCRIBED MATERIAL, UNLESS OTHERWISE INDICATED

CLASSIFICATION OF ATTACHED MATERIAL | CONTROL NUMBER | CLASSIFICATION OF THIS SHEET ONLY

Figure 14-1.–OPNAV 5216/10.

RECEIPT SYSTEM FOR CLASSIFIED MATERIAL

In Navy imaging facilities, whenever Top Secret or Secret material changes hands, it MUST be done under a continuous chain of receipts. This continuous chain of receipts is documented on a Correspondence/Material Control (4 PT), OPNAV 5216/10.

For example, when a requester brings a Secret chart to the imaging facility to be copied, the person receiving the job must sign a receipt for the original Secret chart. When the photographer turns the chart over to the cameraperson, the cameraperson must sign the receipt; when the cameraperson turns the processed film over to the printer, the printer signs for the negative and the print, and so on, until the requester again signs the receipt for the completed job.

Confidential material, on the other hand, needs to be covered by a receipt only when it is transferred, either permanently or temporarily, to another command or other authorized addresses.

The receipts for Top Secret material will be provided by the person requesting the work. For Secret and Confidential material the OPNAV 5216/10 (fig. 14-1) should be completed by the person at the front

desk receiving the job request. OPNAV 5216/10 should be unclassified and contain only the information required to identify the material being received No classified information should be included on a receipt. The postcard receipt (back of OPNAV 5216/10 package) is given to the person delivering the job request. The postcard receipt is then presented to the front desk person when the completed job request is picked up. OPNAV 5216/10 receipts are retained for a minimum period of 2 years.

Whenever you have questions about classified information or security matters, refer to the *Department of the Navy Information Security Program Regulation,* OPNAVINST 5510.1, or the security manager of your command.

VISITOR CONTROL

Physical security is part of an overall Navy program that deals with physical measures designed to prevent unauthorized access to equipment, facilities, and materials.

Navy imaging facilities are a part of this physical security program. Physical security of imaging facilities is a direct, immediate, legal, and moral responsibility of every Photographer's Mate assigned to the activity.

As stated earlier, Navy imaging facilities are considered limited access areas. The reception or job order desk area is the only place within the facility that unescorted personnel, other than personnel assigned to the activity, or visitors are permitted. Beyond the reception area, there must be a definite, well-defined limiting barrier. This barrier may be in the form of a warning sign, locked gate, or a door, depending on the degree of security required.

Procedures for the control of people entering the restricted areas of an imaging facility beyond the barrier include, as a minimum, an escort system. Escorting is a method for controlling personnel within the lab who are not normally authorized access. Whether or not the escort remains with the visitor during the entire time of the visit is determined by the amount of security required, by the purpose of the visit, and by local written policy. Utility and maintenance personnel performing work at regular or irregular intervals and for short working periods should be handled by the same procedures as those used for the control of visitors.

People are curious and like to look at pictures. When unescorted they will probably look through the pictures and negatives in the finishing area Even if they do not take the pictures, they most probably will not place them in the same order and the finishing crew will have to re-sort the jobs.

Even when your imaging facility does not handle classified work, you must become aware of the need for security. You must be accustomed to escorting visitors. By escorting visitors, you will find that the disappearance or misplacement of equipment and materials is minimized

JOB CONTROL

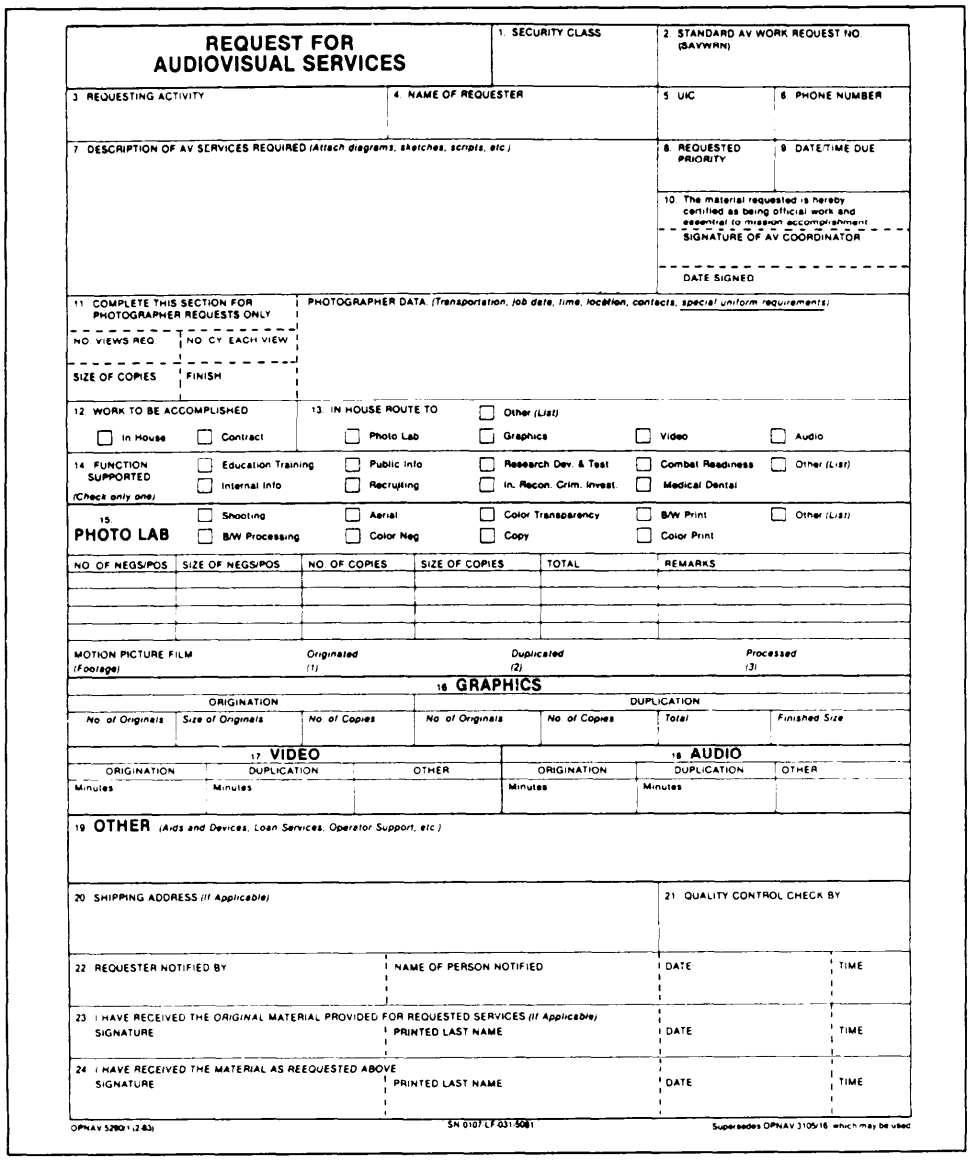
The *Navy Visual Information Management and Operations Manual,* OPNAVINST 5290.1 (series), governs the administration and operation of Navy imaging facilities. It outlines the organization and administration of audiovisual units and provides policies and instructions for the use of imaging products in the Navy. You should consult this manual for the most current information concerning the organization of naval imaging.

The ability to track photographic jobs within your facility quickly and accurately depends on the job control system of your imaging facility. When the system is not used correctly, photographic requests, negatives, prints, and other requirements may be lost or misplaced. This causes an inordinate delay in customer service that has a negative impact on your relationship with other divisions.

JOB-ORDER LOG

An unclassified job-order log is maintained by all imaging facilities. The log must contain, as a minimum, the following information: sequential job order numbers, security classification, product identification, and disposition of the work request (person who picked up the job). Additional data required by your imaging facility, such as date and requester, may also be included in the job-order log.

Unclassified identifiers are used to refer to classified subjects. A separate job-order log is maintained for classified work requests. Job order logs are created on the first day of each fiscal year, and the job order number is reset to 000001. The **fiscal year** of the federal government runs from 1 October to 30 September.



REQUEST FOR AUDIOVISUAL SERVICES

1. SECURITY CLASS
2. STANDARD AV WORK REQUEST NO. (SAVWRN)
3. REQUESTING ACTIVITY
4. NAME OF REQUESTER
5. UIC
6. PHONE NUMBER
7. DESCRIPTION OF AV SERVICES REQUIRED (Attach diagrams, sketches, scripts, etc.)
8. REQUESTED PRIORITY
9. DATE/TIME DUE
10. The material requested is hereby certified as being official work and essential to mission accomplishment
SIGNATURE OF AV COORDINATOR
DATE SIGNED
11. COMPLETE THIS SECTION FOR PHOTOGRAPHER REQUESTS ONLY
PHOTOGRAPHER DATA. (Transportation, job date, time, location, contacts, special uniform requirements)
NO. VIEWS REQ.
NO. CY EACH VIEW
SIZE OF COPIES
FINISH
12. WORK TO BE ACCOMPLISHED
☐ In House ☐ Contract
13. IN HOUSE ROUTE TO
☐ Photo Lab ☐ Graphics ☐ Video ☐ Audio ☐ Other (List)
14. FUNCTION SUPPORTED (Check only one)
☐ Education Training ☐ Internal Info ☐ Public Info ☐ Recruiting ☐ Research Dev. & Test ☐ In. Recon. Crim. Invest. ☐ Combat Readiness ☐ Medical Dental ☐ Other (List)
15. PHOTO LAB
☐ Shooting ☐ B/W Processing ☐ Aerial ☐ Color Neg ☐ Color Transparency ☐ Copy ☐ B/W Print ☐ Color Print ☐ Other (List)

NO. OF NEGS/POS	SIZE OF NEGS/POS	NO. OF COPIES	SIZE OF COPIES	TOTAL	REMARKS

MOTION PICTURE FILM (Footage) — Originated (1) — Duplicated (2) — Processed (3)

16. GRAPHICS

ORIGINATION			DUPLICATION			
No. of Originals	Size of Originals	No. of Copies	No. of Originals	No. of Copies	Total	Finished Size

17. VIDEO

ORIGINATION	DUPLICATION	OTHER
Minutes	Minutes	

18. AUDIO

ORIGINATION	DUPLICATION	OTHER
Minutes	Minutes	

19. OTHER (Aids and Devices, Loan Services, Operator Support, etc.)
20. SHIPPING ADDRESS (If Applicable)
21. QUALITY CONTROL CHECK BY
22. REQUESTER NOTIFIED BY — NAME OF PERSON NOTIFIED — DATE — TIME
23. I HAVE RECEIVED THE ORIGINAL MATERIAL PROVIDED FOR REQUESTED SERVICES (If Applicable) SIGNATURE — PRINTED LAST NAME — DATE — TIME
24. I HAVE RECEIVED THE MATERIAL AS REEQUESTED ABOVE SIGNATURE — PRINTED LAST NAME — DATE — TIME

OPNAV 5290/1 (2-83) S/N 0107-LF-031-5081 Supersedes OPNAV 3105/16 which may be used

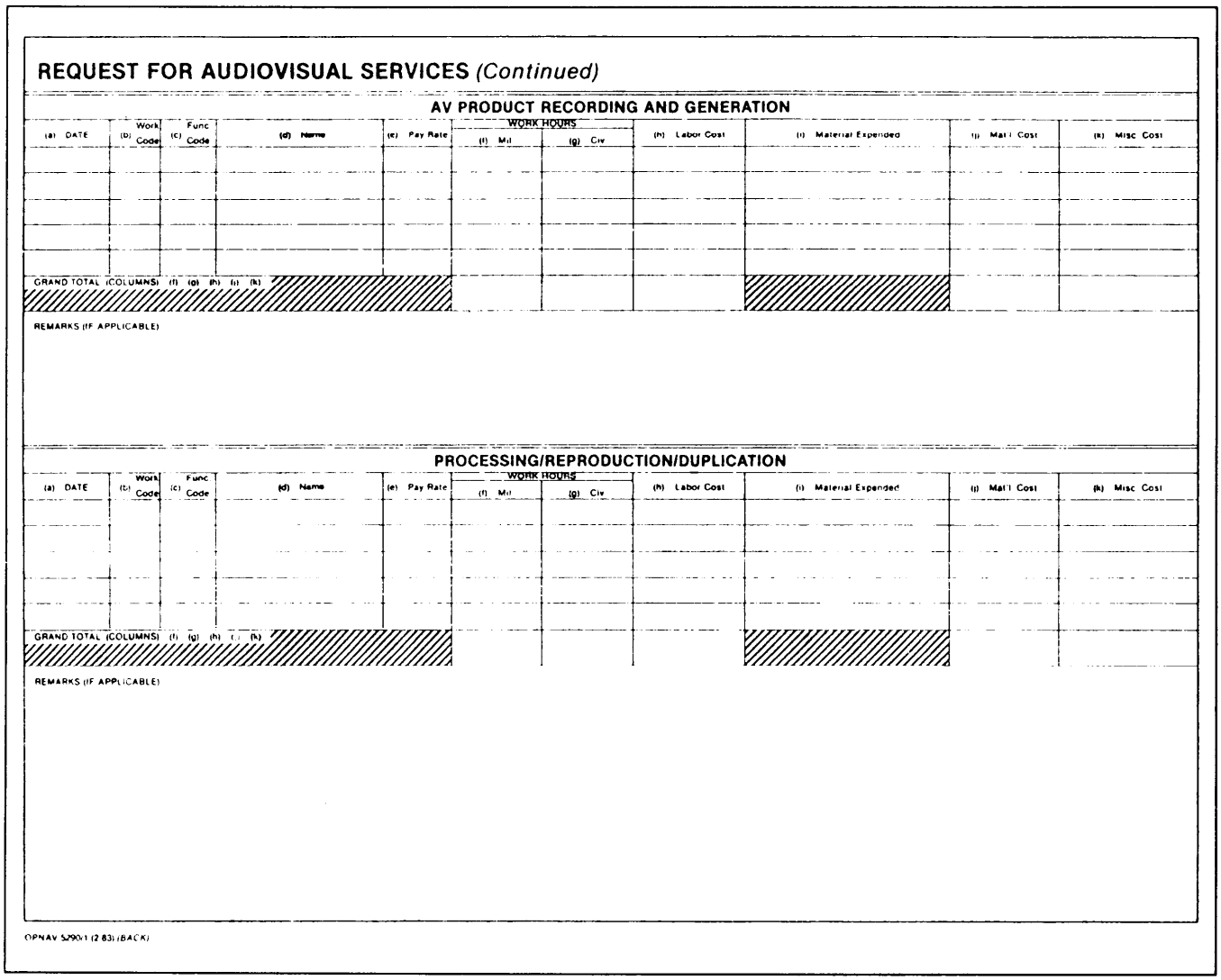
Figure 14-2A.–OPNAV 5290/1 (Front).

VISUAL INFORMATION JOB-ORDER FORM

ALL work performed by Navy imaging facilities must be documented on a job-order form. The job-order form is used to maintain close control of in phases of imaging services. The job-order form serves several purposes; they are as follows: as an official request for visual information (VI) services, as the authority to perform the work, as a record of the time and materials used to complete the job, and as a receipt for the finished work. Navy imaging facilities may use the Request for Audiovisual Services, OPNAV 5290/1 (fig. 14-2A), or a locally created, in-house job-order form.

As a minimum, an in-house job-order form must contain the following information: a job-order number, a customer signature block with a disclaimer that the service requested is official work and essential to mission accomplishment, product security classification, and any other information required by your facility to accomplish the request officially.

Figure 14-2A is an example of an Request for Audiovisual Services, OPNAV 5290/1. Figure 14-2A shows the front side of the form. The front side can be broken down into two sections. The top section, Blocks 1 through 14, may be completed by the requester or a person assigned to the job-control desk by the imaging facility. The completion of these blocks is self-explanatory. Block 2 (the work request number) is the



REQUEST FOR AUDIOVISUAL SERVICES *(Continued)*

AV PRODUCT RECORDING AND GENERATION

(a) DATE	(b) Work Code	(c) Func Code	(d) Name	(e) Pay Rate	WORK HOURS (f) Mil	WORK HOURS (g) Civ	(h) Labor Cost	(i) Material Expended	(j) Matl Cost	(k) Misc Cost
GRAND TOTAL (COLUMNS) (f) (g) (h) (i) (k)										

REMARKS (IF APPLICABLE)

PROCESSING/REPRODUCTION/DUPLICATION

(a) DATE	(b) Work Code	(c) Func Code	(d) Name	(e) Pay Rate	WORK HOURS (f) Mil	WORK HOURS (g) Civ	(h) Labor Cost	(i) Material Expended	(j) Matl Cost	(k) Misc Cost
GRAND TOTAL (COLUMNS) (f) (g) (h) (i) (k)										

REMARKS (IF APPLICABLE)

OPNAV 5290/1 (2-83) (BACK)

Figure 14-2B.–OPNA V 5290/1 (Back).

next sequential job-order number taken from the job-order log. Block 7 (description of services required) is the most important block on the front side. This block must describe the requirements of the requester completely. There are times when you must ask the requester specifically what is desired to meet the necessary requirements. The information provided in this block must indicate the time, equipment, and number of personnel required to complete the assignment. Sketches, diagrams, or other additional information may be attached. Blocks 15, 16, and 17 indicate the quantities of materials needed by the requester. The Remarks block may be used to indicate whether the original film or videotape should be provided to the requester, the file, or be forwarded to an imaging records center.

The back of OPNAV 5290/1 (fig. 14-2B) is divided into two sections. The top half is used to document the production of original materials. The bottom half is used to record processing, reproduction, and duplication. When completing these sections of the job order, you must provide accurate details. The data in these sections are used to justify budget requests for the money and personnel required to provide imaging services by the imaging facility.

NOTE: When assigned to the job-control area, you must be sharp and professional. The image that you portray reflects the professionalism of your entire imaging facility. Most customers never see the production spaces. It is your attitude and appearance that leaves a lasting impression on your customers.

VISUAL INFORMATION CAPTION SHEETS

A Visual Information Caption Sheet, DD Form 2537, must accompany each product forwarded to a Navy still and motion-media records center. (See fig. 13-18.) The use of the visual information caption sheet ensures that all necessary caption information is available and standardized, so it can be entered into the computer data base at the records center.

The instructions necessary to complete DD Form 2537 are printed on the back of the form. Because the completed form provides the cover story images being forwarded, you must provide accurate information and as much detail as possible about the recorded event.

PHOTOGRAPHIC FINISHING

Photographic finishing is just as important as all the other steps in the photographic process. Normally, the final checks for accuracy and quality are performed in the finishing area.

QUALITY ASSURANCE

When the prints are dry and the job order is completed, you must examine them for defects or other poor qualities such as stains, dust spots, fingerprints, and uneven borders. Many times the prints are on long rolls and must be cut and trimmed into individual prints. After the prints are trimmed, you must sort the prints into groups according to the negatives and job orders. At this stage you can ensure there are enough good-quality prints to fulfill the job order. The following checks must also be made: the correct negatives were printed, the correct size was printed, and the negatives were printed on the correct finish (glossy or matt) paper. Negatives that required additional prints or reprints should be sent back to the print room to correct discrepancies. You are responsible for ensuring that only the highest-quality product leaves the imaging facility.

Rejected prints from classified negatives must be disposed of according to the instructions provided in the *Department of the Navy Information and Personnel Security Program Regulation,* OPNAVINST 5510.1 (series). Rejected prints from negatives that are unclassified must be disposed of according to local instructions.

NOTE: It is the policy of most Navy imaging facilities to return all film and paper scraps, test prints, rejected prints, and so forth, from classified jobs to the requester. Be sure to follow the policy established locally by your imaging facility.

Do not neglect to check the completion and accuracy of the job order. Be sure that all personnel responsible for completing the job have completed the appropriate blocks. Materials expended for the job, man-hours, and accountability must be provided on the job order. Remember, without this information, proper budgeting and personnel management within you facility cannot be performed accurately.

MARKING VISUAL INFORMATION PRODUCTS FOR FILING

When the negatives and prints are not returned to the requester, they must be marked and captioned before placing them into the local file or forwarding them to a Navy still and motion-media records center. Classified prints must be marked with the appropriate classification as specified in OPNAVINST 5510.1 (series). Refer to chapter 6 for caption writing requirements if you need to refresh your memory.

The guidelines and procedures for marking visual information (VI) products are in chapter 2 of the *Navy Visual Information Management and Operations Manual,* OPNAVINST 5290.1 (series). You should refer to this instruction for the most current information on marking and identifying imaging products.

Each original product retained in your imaging facility file must be identified and recorded in the Visual Information Record Identification Number (VIRIN) log. The following information must be included in product markings:

- The Department of Defense Visual Information Authorization Number (DVIAN) code
- The VIRIN code
- The last two digits of the fiscal year (FY) in which the image was exposed or recorded
- The six-digit sequence number
- The security classification (if applicable)

  Blank–Unclassified

  CO–Confidential

  SE – Secret

  TS – Top Secret

A complete listing of VIRIN codes is contained in OPNAVINST 5290.1 (series). Some of the more commonly used VIRIN codes are as follows:

OTT–overhead transparency

SCN–still photographic negative, color

SPN–still photographic negative, black and white

SPT–still photographic transparency

VSP–video still

VTC–videotape cassette

Each set of characters in the markings of VI products is separated by a hyphen. An example of a VIRIN is as follows: the first product of FY 93 filed by the Fleet Imaging Command Pacific, San Diego; the subject is classified Secret and was shot by a photographer using a still-video camera. The VIRIN is as follows:

NO108-VSP-93-000001-SE

Each authorized imaging facility is assigned a separate DVIAN code. Each original VI product that is marked and filed by your imaging facility must be recorded in the VIRIN log. The VIRIN-log entries must consist of the VIRIN assigned to each original product, the job-order number, format, subject matter, camera-person or artist's name, and final disposition of the product. Like the job-order log, the six-digit sequence number in the VIRIN log is reset to 000001 the first day of the new fiscal year.

Still Photography

Negatives are marked with the VIRIN on the base side, outside the usable image area with permanent ink Roll negatives are cut into strips and each strip is assigned a separate VIRIN. Individual frames on the strip are then identified by letters (A, B, C, D, and so on). Frames within the strip that are not intended for filing should not be assigned a letter; however, they must not be crossed out.

Transparencies must be mounted in plastic or cardboard mounts with the VIRIN marked on the mount. For still, electronic floppy disks, mark the outside of them with the VIRIN, using permanent ink

Prints

Photographic prints are marked on the base side with the same VIRIN assigned to the original negative or transparency. Prints must also include the date the original photograph was taken and the name and address of the originating activity.

Unclassified photographs that are cleared for public release according to the *Department of the Navy Public Affairs Policy and Regulations Manual*, SECNAVINST 5720.44 (series), must be stamped-"United States Navy Photography. Please credit USN PHOTO."

Classified prints must include the security classification, classification authority, appropriate downgrading and declassification instructions, and be stamped "United States Navy Photography."

Photographic prints of mishaps, accidents (including property damage and personal injury), and other types of evidence that are not releasable under the Freedom of Information Act must be stamped "United States Navy Photography."

Motion Media

Each motion-media roll of film, cassette, or disk must be identified with the same information as still-imaging products. However, the data must be recorded at the beginning of the tape for a minimum of 5 seconds viewing time. The VIRIN should also appear on the outside of the cassette or reel, so the product can be identified without actually viewing it. When possible, the VIRIN should be included on the slate. When the VIRIN is included on the slate, all information is provided in the same frame.

NOTE: Remember that all Navy imaging products forwarded to a visual information records center for pre-accessioning must be accompanied by a Visual Information Caption Sheet, DD Form 2537.

FILING IMAGING PRODUCTS

Images that are stored locally must be protected. Standard, VI file cards are commonly used throughout the Navy to protect and file photographic images. These file cards may be color coded to distinguish classification, subject matter, time frame, and so forth. Standard file cards are made of sturdy paper stock A print of the image, the VIRIN, and the classification are included on the face side of the file card, and the negative and caption are attached to the back. Downgrading instructions must be included for classified images. All negatives filed or handled must be protected by negative preservers.

Photographic negatives and prints should be carefully stored in a file cabinet so they are protected.

You should avoid storing photographic products in cardboard boxes. To prevent damage, never store photographic negatives and prints in storerooms, quonset huts, bilges and so on, where they may be subject to adverse conditions, such as direct sunlight, UV radiation, water, dampness, high humidity, and high temperatures. Videocassettes, audio tapes, and floppy disks must never come in to contact with a magnetic field. A good general rule is to store file images in climatic conditions under which you would be comfortable.

PRINT MOUNTING

For exhibition and display, prints are mounted or matted on a stiff board. The difference between mounting and matting is the way in which a print is attached to the board. When a print is mounted, it is stuck on the face of a mounting board. When a print is matted, it is attached to the back of the board and the image is placed behind a cut opening. When matted, a print is often taped into place, thus the matt can be temporary. Generally, prints that are framed are matted. In both cases, the board enhances the picture by providing a broad border as well as protecting the edges against damage.

When you are preparing a print for exhibition or display, your goal should always be to show the print to best advantage. Simplicity is the best strategy. Elaborate artwork or fancy lettering can often detract from the photograph.

Generally, prints for display purposes are mounted or matted on special card stock to make them stand out from their surroundings. Card stock used for mounting photographic prints should be free of acid or sulfur that can deteriorate the print quality. Card stock is available in various sizes, colors, textures, and weights. There are no hard-and-fast rules for mounting prints, but the card stock should compliment the print. The mount should be large enough to balance and support the picture, and the texture and color should compliment the overall tone.

The way the print is placed on the mounting board is important. Prints mounted at odd angles or in a corner of the mount unbalance the photograph. The bottom border on most mounts is the widest border of all. Normally, prints are mounted so the top and side border of the mount are equal. To provide balance, you should ensure the bottom border is 25 to 35 percent wider than the top and side borders. There are two types of adhesives for mounting prints: wet and dry.

Wet Method

Liquid adhesives, such as rubber cement and spray-on adhesives, can be used to mount prints. These two adhesives are easy and clean to use. After they dry, the excess adhesive can be removed easily by rubbing it lightly. The drawback to using rubber cement and spray-on adhesives is that they are not permanent. In time the print may loosen and peel off the mount. Rubber cement is an ideal adhesive for temporary mounts used in displays or for copying. Gum arabic, glue, or paste should be avoided whenever possible. These adhesives are known to stain the print or smear out from around the edges of the print. This causes smudges on the mounting board.

Dry Method

A dry print-mounting method that uses a pressure-sensitive adhesive is in common use in the Navy. Pressure-sensitive adhesives come in a variety of sizes in both rolls and sheets. These adhesives form a permanent bond and are easy to use for resin-coated papers. To use these materials, you simply apply the print to the sticky surface of the mounting material. You then peel off the protective backing and apply it to a mounting board. If the print is not aligned correctly, you can remove the print and reapply it. Once the print is correctly in place, you must apply pressure to the print and mounting board. Normally, this is done by running the print and mounting board through a specially designed roller assembly. This assembly applies pressure to the materials being mounted. The pressure-sensitive adhesive material contains tiny beads of adhesive. The pressure breaks these beads and releases the adhesive. Once pressure is applied to the materials being mounted, a permanent bond is formed.

A dry-mount press can also be used to mount photographic prints. With a dry-mounting press, heat is used to fuse a mounting tissue between the print and the mounting surface.

A dry-mount press is designed to provide uniform pressure and heat. Even pressure is an important aspect of good, dry mounting. Adequate pressure helps squeeze out air from between the adhesive, print, and mounting board. You should operate the dry-mount press at the temperature recommended by the manufacturer of the mounting tissue. It is better to use a slightly lower temperature to mount prints than a temperature that is too high. Excessive temperatures may cause damage to the print. When temperatures are too high for RC papers, the resin coating blisters or bubbles.

Porous materials, such as mounting board and rag-stock paper, absorb moisture from the air. This moisture becomes trapped between the layers and causes blisters and bubbles in the finished work For best results, you should predry the materials before beginning the dry-mounting process. This can be done by heating the mounting board or paper in the mounting press to remove the moisture.

The time required to form a good bond varies when you are using a dry-mounting press. You should mount the prints for a minimum amount of time-the time required to squeeze out air and moisture from the materials and to activate the adhesive. Because different materials have different thicknesses and heat-conducting characteristics, you must experiment to determine what amount of time is required to form a good mount. Whenever possible, you should use scraps of materials that are the same as your finished work to determine the best time and temperature for dry-mounting prints.

The final stage of finishing for some photographs is to frame them. There is an infinite number of colors and materials available for framing photographs. The same principles apply for framing photographs that apply to mounting or matting prints. Keep it simple and choose a frame that compliments the photograph, rather than distract from the picture.

SLIDE MOUNTING

Unlike photographic prints, slides must be put into slide mounts in order to be of any use. The process of mounting slides ranges from a simple pair of scissors to slide-mounting machines, costing tens of thousands of dollars.

Whenever handling slides, you should wear cotton gloves to avoid fingerprints on the image area. If fingerprints do get on the slides, a cotton ball moistened with film cleaner should be used to remove them.

Slides can be mounted in either cardboard or plastic slide mounts. When using cardboard slide mounts, you must heat them so the slide adheres to the mount. Navy imaging facilities use plastic slide mounts. The slides can be placed in plastic slide mounts manually or by machine.

To mount slides manually, you must cut the roll into individual frames. Normally, this is done on a light table so the edges of the frame can be seen clearly. To mount a slide, you simply slide the frame into an open slit on the edge of the slide mount. On one side of the plastic slide mount is the lettering, “THIS SIDE TOWARDS SCREEN.” The lettering appears along the side of the open slit. The slide is mounted properly when the emulsion side of the film faces the lettering, and the slide is straight. No light should pass between the edges of the film edges and the mount.

When projected slides appear correctly on the screen, they are placed in the projector (or slide tray) upside down and backwards, as viewed from the operator’s position. An operator’s dot is often placed on the slide mount to aid in organizing the slides in the tray. When the slide is viewed with the emulsion side towards you and the image is upside down, the operator's dot is marked on the upper right-hand comer of the slide mount. The slides are placed into the slide tray correctly when the operator's dot can be seen facing the outside of the tray.

APPENDIX I

GLOSSARY

ABERRATION–A defect in the formation of an optical image; for example, astigmatism, chromatic aberration, curvature of field, and so forth.

ABSOLUTE TEMPERATURE–The temperature measured from absolute zero. Expressed as degrees Kelvin (°K) in the Centigrade system where absolute zero is –273°C or in degrees Rankine in the Fahrenheit system where absolute zero is –459°F on the scale.

ACCELERATOR–Chemical constituent of photo–graphic developers that activates the developing agent and swells the gelatin to hasten penetration of the solution. See SODIUM HYDROXIDE, SODIUM CARBONATE, SODIUM META–BORATE, and SODIUM BORATE.

ACHROMATIC COLORS–Colors perceived as having no hue (white, black, gray, and silver).

ACHROMATISM–The absence of chromatic aberration.

ACID, ACETIC–A colorless liquid of pungent odor used in stop baths and in fixing baths. In concentrated form it attacks the skin and produces painful blisters. A concentrated solution of 99% solidifies at 62°F and forms a mass resembling ice (Glacial Acetic–Acid).

ACID, BORIC (BORACIC ACID) H_3BO_3– Colorless, odorless, transparent crystals, or a white amorphous powder. Slightly soluble in water and more soluble in glycerine and alcohol. Used in toning and fixing baths.

ACID, SULFURIC, H_2SO_4– syrupy, odorless liquid, colorless or slightly yellow. Used for preparing a tray–cleaning solution and in fixing and reducing solutions.

ACTION–Movement within a scene being photo–graphed. Also, the picture portion of a motion picture as differentiated from the sound track portion.

ACUTANCE–An objective measure of the ability of a photographic material to show a sharp line of demarcation between contiguous areas receiving low and high exposures. It correlates well with subjective judgments of picture sharpness. It is the mean of the square of the density gradients times the density scale over a boundary.

ADDITIVE PROCESS–Any color process in which a reproduction is formed by a combination of images each of which supplies color in proportion to the color observed in the original scene. In a typical, three–color additive process, the colors of the images are blue, green, and red. See SUB–TRACTIVE PROCESS.

AGC–Automatic gain control. Regulates the volume of the audio or video light levels automatically within a camcorder.

AGITATION–The act of moving a photographic film, plate, or paper in a processing bath or moving the bath relative to the photographic material during processing.

AIR BELLS–(1) Air bells are bubbles of air that prevent contact between a processing bath and localized areas on the surface of a photographic material. (ASA) (2) Undeveloped spots on negatives or prints caused by air bubbles, preventing access of developer.

ALKALI–A water soluble compound capable of uniting with and neutralizing acids. The alkalies commonly used for photographic processing baths are sodium hydroxide, potassium hydroxide, sodium carbonate (monohydrate and anhydrous), potassium carbonate, sodium tetraborate, sodium metaborate, and ammonium hydroxide.

AMBIENT SOUND–Background sound or wild sound. Sound that surrounds the scene or location, received by the microphone and recorded onto magnetic tape.

AMMONIUM THIOSULFATE, $(NH_4)_2S_2O_3$–A white salt freely soluble in water. Used in the preparation of rapid–fixing solutions.

ANALOG–An analog signal that fluctuates exactly like the original stimulus (for example, sweep second–hand clock, phonograph player).

ANGLE OF ACCEPTANCE–The angle that objects must align within to affect the reading of a photoelectric exposure meter.

ANGLE OF FIELD–A property of a lens. The angle subtended by the lines that pass through the center of the lens and locate the diameter of the maximum image area within the specified definition of the lens. Also called angular fields.

ANHYDROUS–Dry, containing no water of crystallization.

ANTICURL BACKING–A transparent, gelatin coating sometimes applied to the opposite side of a photographic film from the emulsion to prevent curling by balancing the forces that tend to curl the film, as it is wet and dried during processing.

ANTIHALATION COATING–A light–absorbing coating applied to the back side of the support of a film or plate, or between the emulsion and the support, to suppress halation (also called antihalation backing). *See* HALATION.

ANTISLUDGE AGENT–A chemical compound added to photographic processing solutions to prevent the formation of sludge. Sodium metaphosphate and boric acid are commonly used for this purpose.

APERTURE–In an optical system, an opening through which light can pass.

APERTURE, CURTAIN–The slit in a focal–plane shutter that permits light to reach the film. The slit size may be either fixed or variable.

ARTIFICIAL LIGHT–Illumination provided by incandescent, fluorescent, or flame sources.

ASPECT RATIO–The ratio of the height to the width of the film or television frame; that is, three units high to four units wide (3:4).

ASTIGMATISM–A lens aberration that causes an off–axis point to be imaged as a pair of lines at right angles to each other and in different focal planes. A lens having astigmatism is unable to image horizontal and vertical lines in the same plane with equal sharpness.

ATMOSPHERIC PERSPECTIVE–Applied to the effect of distance created by atmospheric haze in a photograph. It lightens the tones as the distance increases.

AUDIO TRACK–The area of the videotape that is used for recording audio information.

AUTO IRIS–An automatic control of the lens diaphragm.

AUTOFOCUS–A feature of certain cameras or enlargers by which the image is kept in focus automatically regardless of the degree of reduction or magnification.

AVOIRDUPOIS–The system of weights commonly used in the United States and the British Empire in which the primary unit is the pound (7,000 grains); usually expressed in pounds, ounces, and binary fractions thereof.

BACK LIGHT–Illumination from behind the subject in a direction substantially parallel to a vertical plane through the optical axis of the camera.

BACKGROUND–(1) That part of the landscape which is more distant than the principal object from the camera. (2) A screen, drape, or projected scene used in a photography studio behind the subject.

BACKING PAPER (ROLL FILM)–The protective strip of paper to which the film is attached. Backing paper is usually black on one side and colored on the opposite side. Numerals are usually printed on the colored side in a position where they can be viewed through the camera window. Also called duplex paper. (ASA)

BARN DOOR–Folding wings used in front of studio spotlights to aid in directing the light and to shade portions of the subject from direct illumination.

BASE DENSITY–The density of a film base. No plastic is 100% transparent, so all films have some base density.

BATH–Any chemical solution used in processing photographic materials.

BEAM SPLITTER–An optical system so arranged as to reflect or transmit two or more portions of a light beam along different optical paths.

BELLOWS–The extensible lightproof device that joins the lens board to the film support section of a camera

BLEACH, PHOTOGRAPHIC–(1) To remove an image from a photographic film. Especially to do this by converting a metallic silver image to a halide or other salt that can be removed from the film with hypo. When bleaching is not carried to completion, it is called reducing. (2) Any chemical reagent that can be used for bleaching. (3) Any chemical solution used for bleaching.

BORAX–Sodium tetraborate, $Na_2B_4O_710H_2O$; a mild alkali used as an accelerator in photographic developers, particularly for fine–grain effects.

BRIGHTNESS RANGE–Variation of light intensities from maximum to minimum. Generally refers to a subject to be photographed. For example, a particular subject may have a range of one to four-that is, four times the amount of light is reflected from the brightest highlight as from the least bright portion of the subject.

BULB EXPOSURE–An exposure in which the shutter remains open as long as the shutter release mechanism is depressed.

BURNING IN–In photographic printing, a technique by which selected areas of the image are given extra exposure, and the rest of the image is protected against added exposure.

CABLE RELEASE–A device consisting of a stiff wire encased in an outer flexible covering designed to trip a camera shutter without touching the camera itself. One end is threaded to fit the shutter, and the other has a thumb–operated plunger.

CAMCORDER–A portable video camera with videotape recorder (VTR) and a microphone attached to form a signal unit.

CAMEL-HAIR BRUSH–Term used to define any brush with superfine, soft bristles used for dusting lenses and front surface mirrors.

CAMERA–A lighttight chamber, usually fitted with a lens, through which the image of an object is recorded on a light-sensitive material.

CAMERA, IDENTIFICATION –A type of still-picture camera used primarily for the making of identification photographs.

CAMERA, REFLEX–A camera containing a reflecting mirror within the box, so the image may be focused on a ground glass on top of the camera. A single-lens reflex camera has a device to swing the mirror out of the way during the exposure. A twin-lens reflex camera uses two lenses: one for the viewing image and one for the actual picture-making.

CAMERA, VIEW–A tripod-mounted camera that has incorporated into its construction a long bellows, a rising and falling front, horizontal and vertical swing, lateral shift of front and back, and either a reversible or a rotating back The view cameras versatility is valuable for the correction of distortions in architectural, close-up, and illustration photography.

CAPSTAN–An electrically driven roller that rotates and transports the videotape past the recorder heads at a precise and fixed speed.

CASSETTE–A light-trapped metal or plastic container for a length of roll film to enable it to be loaded into a camera in full light.

CCD–Charged-coupled device, also called a chip. A small, solid-state (silicon resin) imaging device used in a video camera instead of camera pickup tubes. Inside the chip, image-sensing elements translate the optical image into a video signal. Chip cameras are insensitive to burn in.

CELL, PHOTOELECTRIC–A device by which light is transformed into electrical energy. Used as the sensitive element in exposure meters and optical sound reproducers and projectors.

CENTIGRADE –A thermometer scale having 100 divisions between the freezing and boiling points of water in universal use for scientific purposes. Also called Celsius after its inventor. Centigrade temperatures may be converted to Fahrenheit temperatures with the following formula:

$$F=9/5C+32$$

when F = Fahrenheit temperature and C = Centigrade temperature. (PIA)

CENTIMETER–A unit of length in the metric system which is 0.01 of a meter. According to American standards, 1 inch is equivalent to 2.54 centimeters (cm). (PIA)

CHARACTER GENERATOR–An electronic device to create words or graphics that may be electronically inserted or "keyed" over the video picture.

CHARACTERISTIC CURVE–The curve showing the relationship between exposure and resulting density in a developed photographic image. It is usually plotted as the density against the log exposure in candle-meter-seconds. Called also the "H. and D. curve" and the "sensitometric curve." The abscissa is sometimes an arbitrary relative exposure.

CHEMICAL FOG –Fog appearing during development of parts of a film not exposed to light. (PIA)

CHROMAKEY–An electronic special effect that combines two video sources into a composite picture, creating the illusion that the two sources are physically together.

CIRCLE OF ILLUMINATION–The total image area of a lens, only part of which is actually used in taking a picture.

CLOSE-UP–A photograph or a motion-picture scene taken at a very close range that shows intimate detail and captures and holds audience interest.

COATING, LENS–A thin, transparent coating applied to the surface of lenses or other optical parts to reduce reflection.

COINCIDENCE–Agreeing as to position. In a coincidence type of range finder, when the two half images of a distant object are in exact juxtaposition, they are said to be "in coincidence."

COLLIMATED–A beam of light is said to be collimated when all of its rays have been made parallel. See SPECULAR.

COLOR BALANCE–The relationship between the three images composing a color negative or positive that provides an accurate (or, more generally, the most pleasing) reproduction of natural colors. (PIA)

COLOR BARS–A color standard used by the television industry for the alignment of cameras and videotape recordings.

COLOR CHART–Target for test photography composed of pigmented areas having colors of high saturation, often accompanied by gray scales, and useful in both color photography and in black-and-white reproduction of colored objects. An assembly of chromatic samples illustrating a scheme of color classification. (PIA)

COLOR COMPENSATING FILTER–A filter used to change the overall color balance of photographic results obtained with color film and to compensate for deficiencies in the quality of the light when printing color films.

COLOR TEMPERATURE–The temperature to which a black body radiator must be raised in order that the light it emits may match a given light source in color; usually expressed in degrees Kelvin (°K).

COLOR TEMPERATURE METER–An instrument for estimating the spectral quality of a light source or the illumination on a scene and expressing the value in terms of color temperature. (PIA)

COLOR TRANSPARENCY–A positive image in natural colors on a transparent support intended for projection or for viewing by transmitted light. (PIA)

COLORBLIND–Applied to photographic layers having only natural silver halide sensitivity to blue, violet, and ultraviolet rays. (PIA)

COMA–An aberration of a lens that causes oblique pencils of light rays from an object point to be imaged as a comet-shaped blur.

COMPONENT–The processing of RGB (red, green, and blue) channels as three separate channels.

COMPOSITE SIGNAL (Y/C)–(Also called NTSC signal.) The video signal in which luminance "Y" (black and white) and chrominance (red, green, and blue) and sync information are encoded into a single signal.

CONJUGATE DISTANCE–The distances of object and image from the lens are called conjugate distances. For every position that an object may occupy with respect to a lens, there is a corresponding position for the image.

CONTACT PRINT–Print produced by exposure in immediate contact with the original or negative. These prints are the same size as the original or negative.

CONTAMINATION–Foreign matter in a processing solution which impairs its operation.

CONTINUOUS TONE–Photographs in which the detail and tone values of the subject are reproduced by an infinite gradation of gray densities between white and black. (PIA)

CONTRAST, LOW–A term expressing a relationship of image tones in which highlights and shadows are represented by very little difference in densities.

CONTRASTY–Photographic term applied to images showing accentuated highlights and shadows. (PIA)

CONTROL TRACK–The area of the videotape used for recording the synchronization information (sync spikes).

COPY–(l) Any document or photograph to be reproduced. (2) The results of such reproduction. (3) (Verb) The act of reproducing a document.

COPYBOARD–The board, frame, or other device for holding copy to be photographed.

CORROSION–The erosion of metals, as by the action of an acid or an alkali; rusting; oxidation. (PIA)

COUPLER–Chemical compound in color developer that can react with the oxidized developing agent in the sensitized material to form a dye color.

CRITICAL FOCUS–That point of focus at which resolution is at its maximum. (NMA)

CROP–To trim or cut off parts of the picture by printing methods to eliminate superfluous portions, and thus improve the composition.

CROP MARKS–Markings placed on original copy, indicating where part of the top, bottom, or sides of the picture are to be omitted.

CURVATURE OF FIELD–An aberration of a lens that causes the image of a plane to be focused into a curved surface instead of into a plane.

CUTAWAYS (MOTION PICTURE)–Shots of related and previously established outside interest used to divert the audience attention in order to cover jumps in action, screen-direction changes, and passage of time.

D-LOG E CURVE–*See* CHARACTERISTIC CURVE.

DARK SLIDE–The opaque slide that covers the film in a film holder, plate holder, film pack, or film magazine.

DARKROOM–A room in which all light of color quality not safe for undeveloped sensitized materials has been excluded. It is used for loading and unloading and the developing of exposed photographic film or paper.

DENSITOMETER–Device to measure the optical density of an image or base by measuring the amount of incident light reflected or transmitted. (NABDC)

DENSITY–The light-absorbing quality of a photographic image is usually expressed as the logarithm of the opacity. Several specific types of density values for a photograph may be expressed; however diffuse transmission density is one of the most important for photographic transparency materials, such as negatives. Diffuse reflection density is generally of interest for photographic prints.

DEPTH–In a nonstereoscopic picture, an illusion of three-dimensional space that is sometimes created by a combination of favorable lighting and coloring of the set and favorable viewing conditions for the reproduction.

DEPTH OF FIELD–The distance between the points nearest and farthest from the camera that are acceptably sharp at a given lens setting.

DEPTH OF FOCUS–The allowable error in lens-to-film distance within which an acceptably sharp image of the subject focused upon will still be obtained.

DEVELOPER (CHEMICAL)–A chemical reagent used to produce a visible image on an exposed photographic layer.

DEVELOPER, COLOR–A photographic developing solution capable of reducing silver halides with the simultaneous production of an insoluble colored oxidation product in the regions where silver is deposited.

DEVELOPING AGENT–Chemicals used in the photographic processing baths to convert the latent image into a visible and photographically useful image.

DIAPHRAGM–A device, such as a perforated plate or an iris, that limits either the aperture of the lens, the field covered by the lens, or both, depending upon its location.

DICHROIC FOG–A deposit of colloidal silver on a photographic film caused by improper processing. This deposit commonly appears red by transmitted light and greenish by reflected light.

DIFFRACTION (OPTICS)–The bending of light waves around the edges of opaque objects.

DIFFUSER–Device for obtaining diffuse direct illumination, such as a wire screen, piece of cloth, or translucent membrane, placed between a light source and the subject illuminated.

DIFFUSION–(l) (Optical) The scattering of light rays so as to cause the light falling on a surface or passing through an aperture to be coming from all directions in contrast to the regular radiation of light from a point source. Diffusion may be introduced by reflection from a matte surface, by transmission through a frosted or opal glass, or by the use of an integrating bar. When diffusion is complete, a sharp image of the light source can no longer be seen, and its place is taken by a uniform, extended source that emits light equally in all directions. (2) (Chemical) The migration of molecules or ions in a solution tending to reduce a difference in concentration between two adjacent regions.

DIGITAL VTR–A videotape recorder that translates and records the analog video signal in digital form.

DIRECT POSITIVE–A positive image obtained directly from another positive image without the use of a negative.

DODGING–A printing technique in which certain areas being exposed are temporarily shielded, thereby producing a different exposure than that used for the rest of the print.

DROPOUT–A loss of part of the video signal that appears as white glitches. Caused by dirty VTR heads or poor quality videotape.

DRY MOUNTING–A method for mounting photographs or artwork on a support by means of a thermosetting laminate that is heated to effect a bond. (PIA)

DRYING MARK–Spots or streaks on negatives and prints differing in density from the surrounding area, produced by uneven drying of the film during processing.

DUB–Duplication of an electronic recording, either tape to tape, record to tape, or vise versa. Dub is always one generation away from the original recording.

EKTACHROME–A trademark of Eastman Kodak Company for a multilayer reversal color film in which couplers are incorporated in the emulsion layers that form dyes in the emulsion during processing.

EKTACOLOR–A trademark of Eastman Kodak Company for a multilayer color negative film in which dye couplers are incorporated in the emulsion layers which upon development produce dye images complimentary to the object colors. Unused couplers remaining in the emulsion after development provide automatic masking for correction.

ELECTROMAGNETIC SPECTRUM–The entire range of wavelengths, extending from the shortest to the longest or conversely, that can be generated physically. This range of electromagnetic wavelengths extends almost from zero to infinity and includes the visible portion of the spectrum known as light.

EMULSION (SILVER HALIDE)–A suspension of light-sensitive silver salt, especially silver chloride or silver bromide, in a colloidal medium, usually gelatin, used for coating photographic film, plates, or papers.

EMULSION SIDE–That side of a (single coated) photographic film on which the emulsion has been coated

EMULSION SPEED–A comparative measure for a given emulsion of exposure to light required to produce a correctly exposed image.

ENLARGEMENT–A print made from a smaller negative through a projection process.

ENLARGER–A photographic projection printer. (PIA)

EXHAUSTION–The state of depletion reached by a processing solution due to age or use that makes it incapable of producing satisfactory results. (PIA)

EXPIRATION DATE–A date placed on sensitized photographic material packaged by the manufacturers to limit the period during which it is warranted to produce normal results.

EXPLODED VIEW–A photograph showing the correct sequence and relationship of the various parts of an assembly. Also called an exploded photograph.

EXPOSURE–(l) The act of exposing a light-sensitive material to a light source. (2) A section of a film for an individual exposure, as a roll containing six exposures. (3) The time during which a sensitive surface is exposed, as an exposure of 2 seconds. (4) The product of light intensity and the time during which it acts on a film, plate, or paper.

EXPOSURE INDEX–An exposure index is the rating of a film for use in connection with exposure tables, exposure computers, and exposure meters.

EXTENSION TUBE–A device used to increase the lens-to-film distance for extreme closeup photography.

FAHRENHEIT–A thermometer scale, on which, under standard atmospheric pressure, the freezing point of water is 32 degrees, and the boiling point of water is 212 degrees; usually indicated as 32°F and 212°F. Fahrenheit temperatures may be converted to Centigrade temperatures with the following formula:

$$C = 5/9 (F - 32)$$

when C = Centigrade temperature and F = Fahrenheit temperature. (PIA)

FAST–Having a high-photographic speed. The term may be applied to a photographic process as a whole, or it may refer to any element in such a

process, such as the optical system, the emulsion, or a developer.

FAST FILM–Photographic material of relatively high sensitivity to light, having a high-exposure index. (PIA)

FIELD–Scanning lines in one half of one video or television frame. There are two fields (one odd, one even) in a frame. One field equals 262.5 scanning lines that create a total of 525 standard television lines or one frame. Also known as the NTSC signal (U.S. T.V. system).

FILM, COLORBLIND–Film which is sensitive only to light of very short wavelengths (ultraviolet, violet, and blue). (NMA)

FILM, PHOTOGRAPHIC, INFRARED–Film coated with an emulsion especially sensitive to infrared light.

FILM, PHOTOGRAPHIC, ORTHOCHROMATIC (ORTHO)–A black-and-white film coated with an emulsion that is sensitive to ultraviolet, violet, blue, and green radiation. Not being sensitive to red, red objects photographed with orthochromatic films are rendered dark on the print.

FILM, PHOTOGRAPHIC, PANCHROMATIC (PAN)–A black-and-white film coated with an emulsion that is sensitive to ultraviolet, violet, blue, green, and red radiation. The special sensitivity of panchromatic films approach that of the human eye.

FILM, PHOTOGRAPHIC, REVERSAL–A film which after exposure is processed to produce a positive image instead of the customary negative image. Reversal films may be black and white or color.

FILTER–Photographic. A layer of glass, gelatin, or other material used to modify the transmitted light selectively.

FILTER, NEUTRAL DENSITY–One not selective for a certain portion of the spectrum but absorbing all colors equally, thus reducing the intensity of light without changing its chromaticity.

FILTER FACTOR–The number of times exposure must be increased to compensate for light absorbed by a filter.

FIXED FOCUS–The term applied to optical instruments and photographic equipment that are not provided with a means for focusing.

FIXER–A solution used to remove undeveloped silver halides from photosensitized emulsions. The fixer usually contains sodium or ammonium thiosulfate, a hardening agent, and an acid or acid salt.

FIXING AGENT–A photographic chemical that dissolves the silver halides not used for producing an image to preserve the photograph from further photographic effect upon subsequent exposure to light. Common fixing agents are sodium thiosulfate and ammonium thiosulfate.

FLARE–A defect of optical systems in which scattered light resulting from reflections at optical surfaces, the walls of the camera, or imperfections in the optical parts, reaches the image plane and produces an overall fog or flare spot that damages the photographic quality of the resulting record.

FLASH, ELECTRONIC–A high-voltage light source for photographic illumination, producing a momentary flash of light of high intensity in an atmosphere of gas enclosed in a tube that can be used repeatedly. (PIA)

FLAT–An image is said to be "flat" if its contrast is too low. Flatness is a defect that does not necessarily affect the entire density scale of a reproduction to the same degree. Thus a picture may be "flat" in the highlight areas or "flat" in the shadow regions, or both.

FLOATING LID–A lid designed to float on the top of a photographic processing solution to reduce aerial oxidation.

FLOODLIGHT–A photographic light used to produce even lighting on large subjects. A floodlight spreads light evenly over a wide angle, as distinguished from a spotlight that concentrates light in a beam.

FLUID OUNCE–A unit of capacity in the Liquid Measure System equal to 1.8 cubic inches; it is equal to 29.57 milliliters.

FOCAL PLANE–The surface (plane) on which an axial image transmitted by a lens is brought to sharpest focus; the surface occupied by the light-sensitive film or plate in the camera.

FOCAL POINT–The point at which converging rays of light from a lens meet.

FOCUS–(l) The point at which rays of light passing through different parts of a lens converge to form a sharp image of the original. (2) (Verb) To adjust the position of either the lens or focusing screen in a

camera or projector to secure the sharpest possible image of the object.

FOG–Nonimage photographic density. The defect is due either to the action of a stray light, to improperly compounded processing solutions, or to wrongly stored or outdated photographic materials.

FOREGROUND (PHOTOGRAPHY)–That part of the landscape imaged in a horizontal or oblique photograph that is closer than the principal object to the camera. (ASP)

FRAME–(l) Any single exposure contained within a continuous sequence of photographs. (2) The smallest unit in television or film-a single picture. A complete scanning cycle of the two fields every l/30 second. A frame equal to 525 scanning lines.

FREEZE FRAME–Arrested motion that is perceived as a still shot.

FULL APERTURE–The maximum opening of a lens diaphragm. (PIA)

FULL STOP–The standard series of diaphragm markings, or stop openings, that are 0.7, 1.0, 1.4, 2.0, 2.8, 4.0, 5.6, 8, 11, 16, 22, 32, 45, 64, 90, and 128.

FUZZINESS–Lack of image sharpness caused by a defective lens, poor focus, movement, and so forth.

GAIN–The level of amplification for video or audio signals. Increasing the video gain increases the picture contrast.

GENERATION–The number of dubs or copies sway from the original recording. The greater number of generations, the greater loss of picture quality.

GRADUATE–A container for liquids marked off to measure various volumes. (PIA)

GRAIN–The discrete particles of image silver in photographs. The random distribution of these particles in an area of uniform exposure gives rise to the appearance known as “grainiess."

GRAININESS–The subjective impression of non-uniformity in an area of a photograph corresponding to uniform exposure, most often noticeable in enlargements with a magnification of 10 or more.

GRANULARITY–An objective quantitative measure of graininess.

GROUND GLASS–A sheet of glass with a grained or matte (translucent) surface, a focusing screen, diffusing screen, and so forth. (PIA)

GUIDE NUMBER–Values assigned to photographic flood and flash lamps according to American Standard to rate their light output in terms useful in exposure calculation. The guide number for a particular lamp used with a particular film is divided by the distance in feet from the lamp to the subject to find the f/number.

HALATION–A halo or ghost image surrounding the true image of a bright object on a photographic emulsion, caused by reflection of rays of light from the back of the negative material.

HALFTONE–Reproduction of a photograph in which the gradation of tone is reproduced by various sized dots and intermittent white spaces caused by interposing a screen between the lens and the film. (IABPAI)

HALIDE–Any compound of chlorine, iodine, bromine, or fluorine, and silver. Silver bromide, silver chloride, and silver iodide are the light-sensitive materials in silver emulsions.

HANGER, FILM–A frame, usually of metal or plastic, for holding one or more photographic films to facilitate handling during processing.

HARDENER–A chemical that increases the melting point of gelatin in photographic layers and prevents softening in warm-processing baths. Hardeners commonly used in photographic processing baths are aluminum potassium sulfate, chromium potassium sulfate, and formaldehyde solution. (PIA)

HAZE–The presence of foreign matter in the atmosphere to an extent sufficient to reduce even slightly its transparency.

HEAD-ON SHOT–A directionless shot in which the subject comes directly toward the camera. Used to change screen direction.

HEADS–A small assembly within an audio or video recording system that can erase, record, or playback the signal in electromagnetic impulses.

HELICAL SCAN, OR HELICAL VTR (ALSO CALLED SLANT TRACK)–A videotape recording or a videotape recorder in which the video signal is put on tape in a slanted, diagonal way. Because the tape wraps around the head drum in a spiral-like configuration, it is called helical.

HIGH-ANGLE SHOT–A scene photographed on a downward angle; the camera being placed above the action.

HIGH CONTRAST–A term expressing a relationship of image tones in which highlights and shadows are represented by extreme differences of density.

HIGH KEY–A term applied to a photographic print or subject consisting entirely of light tones with little contrast; also applied to a method of lighting a subject.

HIGHLIGHT–The bright parts of a picture or subject that are rendered as dense areas in the negative and by very low density in the print.

HUE–That attribute of certain color perceptions in respect to which they differ characteristically from the gray of the same lightness and which permits them to be classed as reddish, yellowish, greenish, or bluish.

HYDROMETER–Generic term for various instruments designed to determine the specific gravity of liquids. (PIA)

HYDROQUINONE $C_6H_4(OH)_2$–Common photographic developing agent para-dihydoxybenzene.

HYPERFOCAL DISTANCE–The distance from the optical center of lens forward to the nearest plane in acceptable focus when the lens is focused at infinity distance.

ILLUMINANCE–Luminous flux incident per unit area of a surface. Widely known as illumination.

IMAGE, LATENT–The invisible image produced by the action of radiant energy on a photosensitive surface. It may be made visible by the process of photographic development.

IMAGE, NEGATIVE–A photographic image in which the values of light and shade of the original subject are represented in inverse order. In a negative, light objects are represented by high densities and dark objects are represented by low densities.

IMAGE, POSITIVE–A photographic image in which the values of light and shade of the original subject are represented in their natural order. In a positive, light objects are represented by low densities and dark objects are represented by high densities.

IMAGE PLANE–The plane in which the image lies or is formed It is perpendicular to the axis of the lens. A real image formed by a converging lens would be visible upon a screen placed in this plane.

INCANDESCENT–Glowing with heat, such as the tungsten filament in an incandescent lamp.

INCIDENCE–The act of falling upon or affecting, as light upon a surface.

INFINITY–A distance so far removed from an observer that the rays of light reflected to a lens from a point at that distance may be regarded as parallel. A distance setting on a camera-focusing scale.

INFRARED–Pertaining to or designating those rays which lie just beyond the red end of the visible spectrum. They are invisible and are detected by their thermal, photoelectric, and photographic effects. Their wavelengths are longer than those of light and shorter than those of radio waves.

INTERNEGATIVE–An internegative film is a negative derived directly from a color reversal original film. All other color-duplicating negatives derived from any other than reversal film are known as color-duplicating negatives regardless of the generation.

INVERSE SQUARE LAW–The intensity of light received at a point (irradiance) varies inversely as the square of the distance from the source. The law holds for relatively small sources only and is useful in calculating photographic exposures. (PIA)

IRIS DIAPHRAGM–Term applied to the adjustable aperture fitted into the barrel of the photographic lenses and so-called because of the contraction of the aperture resembles that of the iris (pupil) in the human eye. It consists of a series of thin metal tongues overlapping each other and fastened to a ring on the lens barrel, the aperture made smaller or larger by turning the ring. (PIA)

JOGGING–Frame-by-frame advancement of videotape.

KELVIN (°K)–Measurement of the color of light in degrees. Numerically, the Kelvin temperature is equal to the Centigrade temperature plus 273 degrees.

KEY LIGHT–The main source of illumination on a subject. (PIA)

LAMP, PHOTOFLOOD–A lamp designed to yield brilliant diffuse illumination. These lamps are generally short-lived. (NMA)

LAMP, REFLECTOR FLOOD–Light bulb with self-contained silvered surface to act as a reflector.

LAMP HOUSE–That portion of an enlarger, reader, or projector that contains the light source and condensers or mirror.

LAW OF REFLECTION–The angle of reflection is equal to the angle of incidence.

LENS–In photography, the optical instrument or arrangement of light-refracting elements in a group; the whole designed to collect and distribute rays of light in the formation of an image.

LENS, COMPOUND–A lens composed of two or more separate elements with a common axis. (PIA)

LENS, MIRROR–One employing reflecting elements in addition to light-transmitting elements; usually to obtain compactness in telephoto objectives. (PIA)

LENS ELEMENTS–Individual simple lenses that are combined to form a compound lens. (PIA)

LIGHT, AMBIENT–Surrounding light; the general room illumination or light level.

LIGHT, DIFFUSED–Light that does not reach the subject in a single beam but is scattered by a medium, such as clouds, ground glass, spun glass, or thin fabric.

LIGHT, FILL-IN–Secondary illumination directed to illuminate shadow areas and avoid excess contrast. Also known as fill light. (PIA)

LIGHT, INCIDENT–The light that strikes an object, distinguished from the light reflected from or transmitted by the object. (PIA)

LIGHT, POLARIZED–Light in which the electric vector of the wave vibrates in one plane, rather than all planes, as it does in ordinary (unpolarized) light. Light may become polarized by reflection or by passing through optical devices or sheets known as "polarizers."

LIGHT BOX–A device for viewing transparencies or negatives, providing diffuse illumination evenly dispersed over the viewing area.

LIGHT SENSITIVE–Materials that undergo changes when exposed to light. The commonly used photographic light-sensitive materials are the silver halides used in films and papers, diazo dyes, and bichromated gelatin. (PIA)

LIGHTING, FLAT–Illumination of a photographic subject often achieved by frontlighting or multiple sources with diffusers that minimizes contrasts and shadows. (PIA)

LIGHTING, FRONT–Illumination on the subject coming from near the camera position. (PIA)

LIGHTING, INDIRECT–Illumination by means of light reflected to the scene from shielded sources.

LIGHTING, LOW KEY–A type of lighting which when applied to a scene results in a picture having gradations from middle gray to black, with comparatively limited areas of light gray and whites.

LINE COPY–A document consisting essentially of two tones (such as black and white, black and tinted, and brown and buff) without intermediate tones.

LITER–A unit of capacity in the metric system, equivalent to 1.056 quarts in United States customary liquid measurement. (PIA)

LOADING–The insertion of photographic film, plates, or paper into holders, hangers, magazines, and so forth, before exposure or processing.

LONG SHOT–In motion pictures, a scene filmed at a considerable distance from the camera to establish locale. Also applied to scenes which show full-length figures, as opposed to waist-length, head and shoulders, and so forth.

LOW-ANGLE (SHOT)–Where camera is placed low and the scene is photographed at an upward angle.

LUX–Lumen per square meter, a unit of illuminance.

MASK–(l) An opaque sheet of thin material used to limit the area of a picture or to secure white margins on a photograph. (2) A supplementary negative or positive used for the purpose of contrast correction in black-and-white prints. (3) A supplementary positive either on a separate sheet or incorporated in an integral color tripack negative for the purpose of color correction. (PIA)

MATTE–A relatively dull surface on photographic prints, having a very low level of specular reflection.

MATTE BOX–A device attached to the front of a camera to hold mattes, filters, diffusing screens, and so forth, in front of the lens.

MEDIUM–Any substances or space through which light can travel.

METER–A unit of length measurement in the metric system approximately equal to 39.37 inches.

METOL-HYDROQUINONE (M-Q)–Designating photographic developers that use a combination of metol and hydroquinone as the developing agent.

METRIC SYSTEM–A decimal system of measurement based on the meter as the unit of length, the kilogram as the unit of mass, and the liter as the unit of capacity.

MICRON–A unit of length in the metric system equal to 0.001 millimeter.

MILLILITER–A unit of volume in the metric system.

1 mL = 0.03381 fl oz

29.57 mL= 1 fl oz

3785 mL= 1 gal

MILLIMETER–A unit of length measuring 0.001 of a meter; 25.4 millimeters equal approximately 1 inch.

MILLIMICRON–A unit of length in the metric system equal to 0.001 micron. It is also equivalent to 10 angstroms.

MODELING–Photographic term for the feeling of "plasticity" engendered by a photograph or the three-dimensional effect produced in a photograph by effective camera work and lighting. (PIA)

MOTTLE–A photographic defect characterized by nonuniform density differences; usually in the pattern of tiny, circular areas.

MOUNT, BAYONET–A means of quickly attaching or removing a lens or filter by turning through only part of a revolution.

MOUNTING–The process of fastening a photographic print to a support.

NEAR POINT–The nearest object to the camera that is still acceptably sharp when the camera is focused for a given distance.

NEGATIVE, BLACK-AND-WHITE–A photographic image on film or paper in which light tones are rendered dark and dark tones appear light.

NEGATIVE, COLOR–A negative record of the color values of the original object. Not only are light values represented by negative densities but colors are represented negatively by their color complements. (PIA)

NEUTRAL–Hueless or achromatic color; gray. Chemically, a solution that is neither acid nor alkaline. (PIA)

NOISE–Unwanted sounds or electrical interference in an audio or video signal. In the audio track, there is a hiss or humming sound. In the video picture the interference appears as "snow."

NORMAL–Sometimes called the perpendicular. An imaginary line forming right angles with a surface or other lines. It is used as a basis for determining angles of incidence, reflection, and refraction.

NOTCHING CODE–One or more notches of characteristic shape placed by the manufacturer in one edge of a sheet of photographic film to identify the emulsion side and the emulsion type. (PIA)

NTSC–National Television Standards Committee. U.S. standards for television or video signal broadcasting. Also known as the composite signal (Y/C).

OPACITY–(l) The ability of an object to absorb light. (2) Photographic term for the light-stopping power of the silver deposit in negative images. Opacity = 100/Transmittance in percent.

OPAQUING–All handwork on a negative to remove spots or unwanted images.

OPEN FLASH–A method of taking photoflash pictures in which the camera shutter is held open during the flash and then closed.

OPTICAL CENTER–The point, generally within a lens but sometimes exterior to it, at which the optical axis and all chief rays of oblique ray bundles intersect.

ORIGINAL–Material from which copies are made, such as handwritten copy, typed copy, printed matter, tracings, drawings, and photographs. (IABPAI)

OVERCOATING–A thin layer of clear or dyed gelatin sometimes applied on top of the emulsion surface of a film to act as a filter layer or to protect the emulsion from abrasion during exposure and processing.

OVERDEVELOP–To permit a photographic image to be developed too much because of one or more of the following factors: (1) excessive time, (2) excessive temperature, (3) overstrength of developer solution, and (4) excessive agitation.

OVEREXPOSE–To permit too much exposure of a photographic emulsion. This may be caused by (1) too brilliant light, (2) too large an aperture, or (3) too much time.

OVEREXPOSURE–A photographic exposure that exceeds the maximum latitude of the sensitized materials.

OXIDATION–Chemical combination of oxygen with other substances. In photography, the loss of activity of developer solutions is due partly to oxidation of the developing agent with oxygen in the air and partly to oxidation with the silver halide during development. (PIA)

PAN (WITH A CAMERA)–During the course of photographing a scene, to swing the camera around in such a way as to follow the action. Derived from: Panorama. Camera pans are commonly described as slow-pan, fast-pan, swish-pan, and jerky-pan.

PAPER, VARIABLE CONTRAST–Photographic paper coated with emulsions having contrast characteristics grading from soft to hard, depending on the color of the exposing light as modified by a series of filters supplied for that purpose.

PARALLAX–The apparent displacement of an object seen from different points. Commonly encountered in photography in the difference between the image seen in the viewfinder and that actually taken by the lens.

PERSISTENCE OF VISION–A property of the eye that consists of an inability to detect the flickering of a light that exceeds a certain critical frequency.

PERSPECTIVE–The relative size and alignment of objects as recorded on a plane surface; the illusion of three dimensions created on a flat surface.

PHOTOELECTRIC CELL–A cell that converts light energy proportionally into electrical energy. It is used in exposure meters and sound recorders and reproducers.

PHOTOMETER–An instrument for measuring the visual intensity of light, specifically for comparing the relative intensities of light emitted from different sources of illumination. (PIA)

PICKUP TUBE–The imaging device of a video camera that converts light into electrical energy-the video signal.

PINHOLE–(l) Term applied to tiny spots in a photographic negative; usually produced as the shadow of a dust particle during exposure, more rarely the result of chemical dust contamination or gas bubble formation in the gelatin layer due to improper processing. (2) Tiny or white or clear areas in a print or drawing material.

PINT, LIQUID–A unit of capacity equal to 16 fluid ounces, or 473.17 milliliters.

PIXEL–The smallest single picture element with which an image is constructed. The light-sensitive elements in a CCD (chip) camera.

PLANE–A surface which has no curvature; a perfectly flat surface.

POLARIZER–An optical device for converting unpolarized, or natural light, into polarized light.

POSITIVE, BLACK AND WHITE–A photographic image on film, plate, or paper in which light tones appear light and dark tones are rendered dark

POSITIVE FILM–Photographic film, designed for the printing of positive transparencies from negatives.

POSITIVE PRINT–A print in which the light and dark areas as they exist in the original.

POTASSIUM BROMIDE (BROMIDE OR POTASH), KBr–White crystals, very soluble in water. Used as a restrainer in developing solutions. Also used in bleaches and clearing solutions.

POTASSIUM HYDROXIDE KOH–Caustic alkali used as an accelerator in photographic developers. Concentrated solutions are quite caustic and will attack the skin, causing painful burns. Similar to sodium hydroxide.

POWER, RESOLVING–The measure of the ability of a lens, a photographic material, or a combination of both, to distinguish detail under certain specific conditions, among which are the shape and contrast of the target, the quantity of illumination, the exposure and the method of processing. The measure of this ability is expressed in lines per millimeter or in angular resolution of a lens.

PREROLL–To start a videotape and let it roll for a few seconds before it is put in the playback or record mode, so the electronic system has time to stabilize.

PRESERVATIVE–The ingredient of a photographic developer that protects it from rapid oxidation.

PRINTER, CONTACT–A photographic printer in which the negative is held in contact with print material during the exposure. The image of a print made with a contact printer is the same size as the image in the negative.

PRINTER, PROJECTION–A photographic printer in which the negative is positioned some distance from the print material; the image being projected onto the print material. The image of a print made with a projection printer is usually larger than the image in the negative.

RADIANT ENERGY–Energy in the form of an electromagnetic wave; for example, gamma rays, X rays, ultraviolet energy, light, infrared energy, radiant heat, and radio waves.

RADIATION–The process of emitting electromagnetic energy.

RECIPROCITY LAW–Exposure is equal to the intensity of the exposing light multiplied by the time during which it acts. The same density should be produced in a photosensitive material by an equal exposure obtained by doubling the intensity of the light and cutting the time of the exposure in half. This law is only approximately followed by photographic materials, and deviations from it are known as "reciprocity law failures."

RECTILINEAR–In a straight line. When applied to a lens, it indicates that images of straight lines produced by the lens are not distorted.

REDUCING AGENT–A chemical constituent of a photographic developer that changes the exposed silver halide to metallic silver. Reducing agents must be combined with other chemicals to confine their activity to the silver grains that have been exposed, to control the rate of reaction, and to preserve the agent from combining with oxygen in the air before it can do the work of development. Reducing agents are also called photographic developers.

REFLECTED LIGHT–Light that has been deflected from an opaque surface; not having been absorbed.

RELATIVE APERTURE–The relative aperture is the ratio of equivalent focal length to the diameter of the effective aperture. The symbol for relative aperture written as a fraction is f/ followed by a numerical value. To illustrate, the expression f/2 signifies that the diameter of the effective aperture is one half of the focal length.

RELATIVE HUMIDITY–Ration of aqueous vapor present in a space at a given temperature, as compared with the greatest amount it could possibly contain at that temperature.

REPLENISHER–An additional agent used to maintain the chemical strength of a processing solution at a constant level. (NMA)

RESOLUTION–In optics, the ability of a lens system to reproduce an image in its finest details. See RESOLVING POWER.

RESOLVING POWER–The degree to which a lens, optical system, or film emulsion is able to define the details of an image, expressed as the maximum number of black lines, with equal white interspaces per millimeter discernible in the image. Results obtainable for a given lens or emulsion vary with contrast of the original image and with development.

RESTRAINER–The ingredient of a photographic developer that prevents too rapid development and that minimizes chemical fog.

RETICULATION–A processing defect affecting gelatin layers on a photographic film which, upon drying, shows an irregular surface due to the formation of small, irregular scaly patterns. Sharp differences in the temperatures of successive processing solutions and insufficient hardening of the gelatin are the usual causes of reticulation.

RGB–The separate red, green, and blue color (chrominance), or "C", video signals.

SCALE, FOCUSING–A calibrated scale that permits focusing a camera without the use of a range finder or ground glass.

SCRIM–Diffusing medium placed in front of lamps.

SEMIMATTE–A surface having a moderate, interrupted sheen midway between glossy and dull, or full matte.

SENSITIVITY–The degree to which an emulsion reacts by the formation of a latent image under given exposure conditions, especially as this relates to exposure by different wavelengths (colors) of light. (NMA)

SENSITIZING DYE–Any dyestuff used for sensitizing a photographic emulsion.

SENSITOMETER–An instrument with which a photographic emulsion is given a graduated series of exposures to light of controlled spectral quality, intensity, and duration.

SHADOW–General term for the thinner areas of a negative or the darker areas of an original.

SHOT–(1) Motion picture. The most basic unit of a film; a single scene; the continuous action occurring from the time the camera is turned on to the time it is turned off. (2) Still picture. A single exposure or photograph.

SHUTTER, BETWEEN-THE-LENS–A shutter whose blades operate between two elements of the

lens, as differentiated from the focal plane or behind-the-lens shutters. Sometimes applied to an iris diaphragm whose blades operate between lens elements.

SHUTTER, FOCAL-PLANE–A shutter located near the focal plane and consisting of a curtain with a slot that is pulled across the focal plane to make the exposure. The width of the slit and the speed it is moved determine the duration of the exposure.

SHUTTER RELEASE–A device to actuate a camera shutter.

SHUTTER SPEED–The length of time that light is permitted to act upon film or paper as a result of the shutter having opened and closed.

SILHOUETTE–An art term for the outline of a form in black or white that is offset by a background of the contrasting color. (PIA)

SILVER HALIDE–A compound of silver and one of the following elements known as halogens: chlorine, bromide, iodine, and fluorine. (NMA)

SLANT TRACK–Same as helical scan.

SODIUM HYDROXIDE (CAUSTIC SODA, SODIUM HYDRATE), NaOH–A deliquescent white material usually available as pellets, flakes, or sticks. Soluble in water with the liberation of heat. A very active accelerator used in high-energy developers. Concentrated solutions are quite caustic and will attack the skin, causing painful burns.

SODIUM THIOSULFATE (THIOSULFATE OF SODA, HYPO) $Na_2S_2O_35H_2O$–Colorless crystals, very soluble in water. It is the principal constituent of most fixing solutions. It may be available in the anhydrous form.

SOFT–(l) As applied to a photographic emulsion or developer, having a low contrast. (2) As applied to the lighting of a set, diffuse, giving a flat scene in which the brightness difference between highlights and shadows is small.

SOFT FOCUS–An unsharp photographic image or a special lens or exposing technique by means of which it is produced. (PIA)

SPECIFIC GRAVITY (LIQUID AND SOLID)–The ratio of the weight of a substance to the weight of an equal volume of distilled water.

SPECULAR–Like a mirror, reflecting in a regular manner so that clear images may be formed, nondiffusing.

SPOT–A contraction of “spotlight”; a lamp which projects a narrow, strong beam of light. (Verb) To remove spots from photographic prints, sometimes called "positive retouching" or"print retouching."

SQUEEGEE–(l) A rubber blade mounted in a holder which, when drawn over the surface of a wet film or paper, removes the surface liquid. (2) Rollers used for the same purpose. (3) On continuous processing machines, air squeegees may be used that remove surface liquid by either suction or by blowing air against material being processed.

STAIN–A local or general discoloration of negatives and prints.

STEP TEST–(l) A series of exposures made with gradual increases in illumination used to determine proper exposure conditions. (2) To test for contrast or latitude, you can use a step wedge in a single exposure. (NMA)

STOP BATH–A stop bath is an acid solution used to arrest development by neutralizing the alkaline developer with which the photographic material is saturated as it leaves the developing bath.

STROBE–Designates an electronic flash lamp.

SUBTRACTIVE PRIMARIES–The three printing colors used in three-color subtractive color processes: magenta (minus green), cyan (minus red), and yellow (minus blue-violet). (PIA)

SYNCHROFLASH –Photographic arrangement whereby a photoflash lamp is timed to provide illumination at the instant when the camera shutter is wide open.

TIME BASE CORRECTOR (TBC)–An electronic accessory to a videotape recorder that helps make playbacks or transfers electronically stable. A TBC helps to maintain picture stability even in dubbing-up operations.

TIME TEMPERATURE CHART–A table showing the optimum time of development at the standard temperature for various photographic materials in a given developer or for different times of development in order to obtain equivalent development at nonstandard temperatures. (PIA)

TONE–(l) In a photographic negative or print, the degree of lightness or darkness of the various parts of the image. (2) A term applied to the color of the image in a photographic print; that is, warm, cold, sepia, and so forth.

TRANSILLUMINATE –To illuminate through a document, from the side opposite the camera.

UNDERDEVELOPMENT –Insufficient development; due to developing for too short a time, use of a weakened developer or, occasionally, too low a temperature.

UNDEREXPOSURE–Insufficient exposure of a photographic material, causing thin or weak images and a corresponding loss of detail. (PIA)

VANISHING POINT–In a perspective view, the point where parallel lines receding from the observer seem to come together.

VELOCITY OF LIGHT–Term applied to the speed of light waves in a vacuum (Co); 229,792.5 kilometers per second, or approximately 186,000 miles per second. In all other media, light travels at a slower rate.

VIDEO CASSETTE–A plastic container in which a videotape moves from a supply reel to a take-up reel. Used in all but the 1-inch VTRs.

VISIBLE SPECTRUM–The portion of the electromagnetic spectrum to which the retina is sensitive and by which we see. Extends from about 400 to 750 millimicrons in wavelengths of radiation.

VTR–Videotape recorder or recording. Includes video cassette recorders.

WASHING–Act of removing soluble chemicals from photographic layers through the agency of water, especially the removal of fixation products and hypo in order to avoid subsequent fading or discoloration of the silver image.

WATER SPOTS–Deformation of photographic gelatin layers on a film or plate due to differential drying when water drops stand on the surface and keep the gelatin wet and swollen after the surrounding gelatin has become dried and compressed. The spots have a characteristic appearance when a negative on which they occur is printed. Viscose sponges and wetting solutions (detergents) are commonly used to avoid such defects. (PIA)

WAVELENGTH–Length of a wave measured from any point on one wave to the corresponding point on the next wave; usually measured from crest to crest. Wavelength determines whether radiant energy is classed as gamma rays, X rays, or ultraviolet, visible, infrared radiant energy, or radio. Wavelength of visible radiant energy is the chief determinant of its perceived color.

WETTING AGENT–A chemical added to water to reduce surface tension, thereby improving wetting characteristics and reducing the formation of water drops. (NMA)

Y/C–The separate processing of the luminance (Y) and chrominance (C) signals.

APPENDIX II

FORMULAS

Relative Aperture: $f = \frac{F}{D}$

Hyperfocal Distance: $H = \frac{F^2}{f \times C}$

Near Distance: $ND = \frac{H \times D}{H + D}$

Far Distance: $FD = \frac{H \times D}{H - D}$

Ratio between image size and object (subject) size: $R = \frac{Image\ size}{Object\ size}$

Object Focal Distance: $F + (F \div R)$

Image Focal Distance: $F + (F \times R)$

IFGA: $\frac{I}{F} = \frac{G}{A}$

Filter Factor Exposure Compensation: $\frac{ISO}{Filter\ Factor}$

or

$Shutter\ Speed \times Filter\ Factor$

Exposure: $E = I \times T$ or $H = E \times T$

Bellows Extension:

New Exposure Time $(\frac{BE}{FL})^2 \times T$

or

Adjuted f/stop: $\frac{indicated\ f/stop \times focal\ length}{lens\text{–}to\text{–}film\ distance}$

Fahrenheit to Celsius: $°F - 32 \times 5/9$

Celsius to Fahrenheit:	$°C \times 9/5 + 32$
Changing Solution Strength:	$\frac{\textit{Amount Wanted}}{\textit{Strength on Hand}} \times \textit{Strength Desired}$
Exposure Time (in seconds) for Motion-Picture Camera:	$\frac{\textit{Shutter-Degree Opening}}{360 \times \textit{fps}}$

APPENDIX III

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Assignment Questions

Information: The text pages that you are to study are provided at the beginning of the assignment questions.

ASSIGNMENT 1

Textbook Assignment: "Theory of Light and Optical Principles." Pages 1-1 through 1-37.

Learning Objective: Identify principles and characteristics of light.

1-1. In what range of the electromagnetic spectrum does light exist?

1. lnm to 100,000nm
2. 10nm to 10,000nm
3. 100nm to 1,000nm
4. 400nm to 700nm

1-2. What theory was published by Max Planck to explain X ray, radiation, and photoelectricity?

1. Wave motion
2. Quantum
3. Raster
4. Electromagnetic

1-3. What theory explains reflection, refraction, diffraction, and polarization?

1. Wave motion
2. Quantum
3. Photo optics
4. Electromagnetic

1-4. A nanometer is equal to what number of millimeters?

1. 1/10
2. 1/100
3. 1/1,000
4. 1/1,000,000

1-5. The speed of light is always constant.

1. True
2. False

1-6. The distance from the crest of one wave to the crest of the next wave of light describes what term?

1. Frequency
2. Speed
3. Wavelength
4. Distribution

1-7. What color of light is made up of an even mixture of all the visible wavelengths?

1. White
2. Black
3. Blue
4. Green

1-8. The spectral energy of a light source is represented by

1. speed
2. frequency
3. wavelength
4. color temperature

1-9. The color temperature of red light is less than the color temperature of blue light.

1. True
2. False

1-10. What scale is used to measure the color temperature of light?

1. Fahrenheit
2. Celsius
3. Kelvin
4. Chromaticity

1-11. Color hue is defined as what property of color?

1. Brightness
2. Purity
3. Saturation
4. Color

1-12. The terms dull, bright, vivid, and brilliant are used to describe what color characteristic?

1. Hue
2. Brightness
3. Saturation
4. Purity

Learning Objective: Identify ways in which light reacts with various mediums.

1-13. When light waves encounter an object, which of the following actions may take place?

1. Reflection
2. Absorption
3. Transmission
4. Each of the above

1-14. Specular light strikes a smooth surface at 60 degrees. At what angle is the light reflected?

1. 30 degrees
2. 60 degrees
3. 90 degrees
4. 120 degrees

1-15. Which of the following descriptors best defines an object that is opaque?

1. Very hard
2. Highly reflective
3. Light stopping
4. Each of the above

1-16. A change in direction that occurs when light passes from one transparent medium into another is known by what term?

1. Refraction
2. Reflection
3. Diffraction
4. Dispersion

1-17. What characteristic of light allows a lens to form an image?

1. Reflection
2. Diffraction
3. Refraction
4. Dispersion

1-18. Of the following wavelengths, which one has its speed reduced the most when it enters a medium of higher density?

1. Red
2. Yellow
3. Green
4. Blue

1-19. What term describes the ability of a prism to break up white light into its component colors?

1. Refraction
2. Diffraction
3. Dispersion
4. Polarization

1-20. A light ray is bent as it passes very close to an opaque object. What term is used to describe this event?

1. Dispersion
2. Refraction
3. Polarization
4. Diffraction

1-21. When the motion a light wave is in one direction only, the light is

1. parallel
2. polarized
3. planed
4. directionless

1-22. What type of light is seen as glare?

1. Plane polarized
2. Diffused
3. Tungsten
4. Fluorescent

Learning Objective: Recognize various sources of light and the differences between them.

1-23. What color of light is scattered the most by the atmosphere?

1. Red
2. Green
3. Yellow
4. Blue

1-24. What is the approximate color temperature of overhead sunlight on a clear day?

1. 2000 K
2. 3200 K
3. 5400 K
4. 60000 K

1-25. You have exposed daylight balanced color slide film under fluorescent light without a filter. What color cast do the finished slides have?

1. Blue
2. Green
3. Yellow
4. Red

1-26. What is the main purpose of a lamp reflector?

1. To increase the amount of light emitted by a lamp
2. To diffuse light
3. To polarize light
4. To redirect light

1-27. Most electronic-flash units are designed to be most efficient when they are at what distance from the subject?

1. 3 to 10 feet
2. 6 to 12 feet
3. 10 to 18 feet
4. 12 to 36 feet

Learning Objective: Identify basic characteristics of photographic lenses.

1-28. The inherent errors of a lens are known by what term?

1. Faults
2. Defects
3. Aberrations
4. Parallax

1-29. The inability of a lens to focus sharply both horizontal and vertical lines on the same plane is what lens aberration?

1. Astigmatism
2. Coma
3. Spherical
4. Chromatic

1-30. The distance from the optical center of the lens to the film plane is 150mm. The image on the film is in sharp focus. The lens is focused on an object at infinity or 640 feet away. What is the focal length of this lens?

1. 50mm
2. 85mm
3. 135mn
4. 150mm

1-31. The focal length can be changed in what type of lens?

1. Mirror
2. Zoom
3. Macro
4. Anamorphic

1-32. What factor determines the normal focal-length lens for a camera?

1. Film size
2. Shutter type
3. Camera size
4. Lens-to-film distance

1-33. Providing the camera-to-subject distance remains unchanged, which of the following focal-length lenses provides the greatest subject area?

1. 200mm
2. 100mm
3. 50mm
4. 25mm

1-34. Which of the following focal-length lenses used at the same lens-to-film distance will produce the largest image of the subject?

1. 135mm
2. 80mm
3. 50mm
4. 25mm

1-35. The angle of field for a normal lens is within a range of how many degrees?

1. 25° to 35°
2. 45° to 55°
3. 75° to 85°
4. 95° to 105°

1-36. What type of lens has an angle of view greater than 55 degrees?

1. Telephoto
2. Mirror
3. Wide angle
4. Long-focal length

1-37. What is the final result when an image is recorded with a lens that has a large diaphragm opening?

1. Moving objects appear sharp
2. All objects within the scene appear sharp
3. Angle of view is increased
4. Only the object the lens is focused on appears sharp

1-38. Photographic perspective depends on the focal length of the lens.

1. True
2. False

1-39. The lens you are using is focused on infinity and set at f/8. The size of the aperture is 1/2 inch. What is the focal length, in inches?

1. 1
2. 2
3. 8
4. 4

Learning Objective: Recognize the function and the effects of the aperture of a lens.

1-40. The lens you are using is set at f/16 and is focused less than infinity. What is the relative aperture of the lens?

1. f/8
2. f/11
3. f/16
4. f/22

1-41. What is the relative aperture of a 6-inch lens with an effective aperture of 1.5 inches?

1. f/4
2. f/5.6
3. f/8
4. f/11

1-42. Three lenses of different focal lengths are used at the same f/stop to photograph the same subject. What lens, if any, produces the brightest image on the film plane?

1. 200mm
2. 50mm
3. 28mm
4. None

1-43. Which of the following terms describes the device within a lens that controls the amount of light passed by the lens to the film plane?

1. Concentricizer
2. Diaphragm
3. Adjuster
4. Obstructor

1-44. What term is used to describe the largest aperture of a lens?

1. Refraction index
2. Closed-down aperture
3. Lens speed
4. Optimum aperture

1-45. Which of the following f/stops represents the largest aperture?

1. f/5.6
2. f/8
3. f/22
4. f/32

1-46. You have changed the lens setting from f/5.6 to f/16. What term describes the action you have taken?

1. Stopping down
2. Opening up
3. Racking out
4. Sliding back

1-47. You have changed the f/stop setting from f/16 to f/8. What amount of light is admitted to the film plane?

1. One half
2. Two times
3. One quarter
4. Four times

1-48. A lens set to f/8 produced a correct exposure in 1 second. When you set the lens at f/4, what is the correct exposure time, in seconds?

1. 1
2. 2
3. 1/2
4. 1/4

1-49. Of the following f/stops, which one is not a standard, full f/stop?

1. f/l
2. f/2.5
3. f/5.6
4. f/45

Learning Objective: Identify factors that affect the means in which a lens focuses an image.

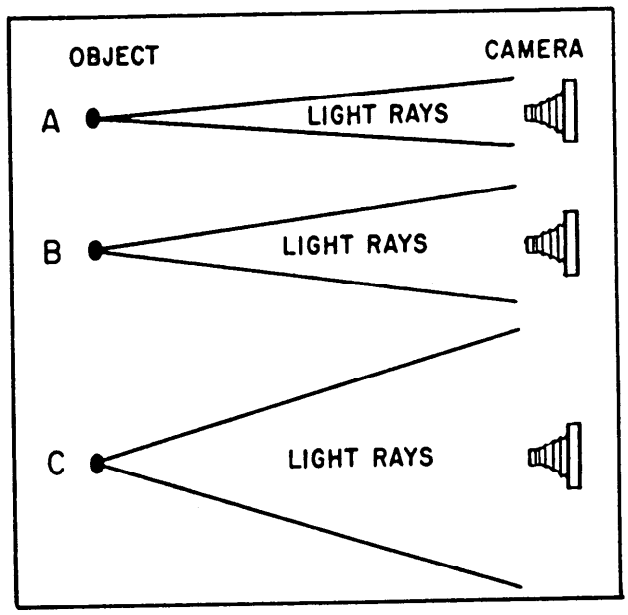


Figure 1A

IN ANSWERING QUESTION 1-50, REFER TO FIGURE 1A.

1-50. What object is represented as being the greatest distance from the camera?

1. A
2. B
3. C

1-51. The principal focal plane is located a total of how many inches behind a 3-inch focal-length lens?

1. 1.5
2. 6
3. 3
4. 4

1-52. As an object moves closer to the lens, what distance, if any, must the film plane to the lens change in order to keep the image in sharp focus?

1. It must be increased
2. It must be decreased
3. None

1-53. What distance is required between the lens and the focal plane so the image formed by a 2-inch focal-length lens is the same size as the subject?

1. 1 inch
2. 2 inches
3. 1.4 inches
4. 4 inches

1-54. The distance the focal plane can be moved forward or backward from the plane of sharp focus and still record an acceptably sharp image is known by what term?

1. Depth of field
2. Circle of confusion
3. Depth of focus
4. Hyperfocal distance

1-55. What term describes the distance from the lens beyond which all objects are rendered in acceptably sharp focus when the lens is set at infinity?

1. Hyperfocal distance
2. Depth of field
3. Depth of focus
4. Near distance

1-56. What is the hyperfocal distance of a 6-inch lens set at f/11 when the permissible circle of confusion is 0.006 inches?

1. 2.38 feet
2. 36.72 feet
3. 545.45 feet
4. 3361.11 feet

1-57. Your lens is set at f/11, the hyperfocal distance is 71 feet, and your subject is 112 feet from the camera. You should focus at what distance for maximum depth of field?

1. 35.5 feet
2. 56.0 feet
3. 71.0 feet
4. 112.0 feet

1-58. Of the following lenses, which one provides the greatest depth of field when set at f/5.6 and focused on an object 6 feet from the lens?

1. 35mm
2. 50mm
3. 80mm
4. 135mm

1-59. Which of the following factors affects depth of field?

1. Lens focal length
2. Lens f/stop
3. Camera-to-subject distance
4. All of the above

1-60. You are using a lens focused on the hyperfocal distance which is 50 feet. What is the approximate depth-of-field range?

1. 25 feet to 75 feet only
2. 25 feet to infinity
3. 50 feet to infinity only
4. 75 feet to infinity only

1-61. What is the depth of field of a 50mm lens set at f/8 with a permissible circle of confusion of 0.002 inches when it is focused on an object 20 feet from the lens?

1. 10.0 feet to 20.0 feet
2. 15.7 feet to 23.4 feet
3. 18.6 feet to 21.7 feet only
4. 20.0 feet to 23.8 feet only

Learning Objective: Determine the relationship between the subject/image size.

1-62. A document is 1-inch square. You must photograph it to produce a 4-inch-square image on the film. Using a 6-inch lens, what image focal distance is required?

1. 10 inches
2. 12 inches
3. 24 inches
4. 30 inches

1-63. The size of the image formed by a lens depends on which of the following factors?

1. The size of the subject
2. The lens-to-subject distance
3. The lens focal length
4. All of the above

1-64. A 10-inch focal-length lens is used to photograph an object 8 feet high from a distance of 28 feet. What image size is on the film plane?

1. 1.25 inches
2. 2.50 inches
3. 2.85 inches
4. 5.70 inches

1-65. You are assigned to photograph an object 10 feet wide using a 4x5-inch camera with a 7-inch lens. You must position your camera what distance from the object to produce a 3-inch image?

1. 1.40 feet
2. 11.65 feet
3. 23.30 feet
4. 46.60 feet

1-66. Using a 35mm camera with a 50mm lens, you have photographed a subject. However, the shooting-crew supervisor informs you that a 4x5-inch negative is required. You cannot change your shooting position. What focal-length lens should you use on the 4x5 camera to obtain approximately the same coverage produced with the 35mm camera?

1. 360mm
2. 210mm
3. 90mm
4. 65mm

Learning Objective: Identify various types of lenses and their characteristics.

1-67. Which of the following are characteristics of a long-focal-length lens?

1. They have a reduced depth of field
2. They decrease the apparent distance between subjects on different planes
3. Both 1 and 2 above
4. They introduce image distortion

1-68. A wide-angle lens has which of the following characteristics?

1. Increased depth of field
2. Exaggerated linear perspective
3. Increased apparent distance between planes
4. All of the above

1-69. When photographing a building, you notice in the viewfinder that the sides of the building appear to be bending toward the center of the image area. What type of lens is on your camera?

1. Rectilinear
2. Wide angle
3. Normal
4. Telephoto

1-70. The distortion caused by wide-angle lenses actually changes perspective.

1. True
2. False

1-71. Which of the following lenses is very useful for taking pictures of extreme closeups shots?

1. Fisheye
2. Rectilinear
3. Telephoto
4. Macro

1-72. Of the following lenses, which one is best for taking informal portraits with a 35mm camera?

1. 100mm
2. 50mm
3. 35mm
4. 17mm

1-73. You are photographing a row of aircraft on the flight deck. Using a medium-format camera, you should use which of the following lenses to make the aircraft appear to be parked very close to each other?

1. 500mm
2. 150mm
3. 75mm
4. 40mm

1-74. Of the following characteristics, which one is NOT representative of a mirror lens?

1. Shorter physical size
2. Out-of-focus highlights that record as rings of light
3. Wide range of f/stops
4. Limited depth of field

1-75. What type of lens is used to change the image size without changing the lens-to-film distance?

1. Macro
2. Zoom
3. Mirror
4. Telephoto

ASSIGNMENT 2

Textbook Assignment: "Light-Sensitive Materials" and "Photographic Filters." Pages 2-1 through 3-12.

Learning Objective: Identify basic characteristics of light-sensitive materials.

2-1. What type of salts is used to make photographic film?

1. Gelatin
2. Halide
3. Oxide
4. Silver

2-2. Undyed silver halides are sensitive to what color of light?

1. Blue
2. Green
3. Yellow
4. Red

2-3. What portion of photographic film or paper is light sensitive?

1. Base
2. Emulsion
3. Antihalation backing
4. Overcoating

2-4. What is the primary purpose of the base portion of photographic film and paper?

1. It prevents the emulsion from being damaged
2. It suspends the silver halides
3. It supports the emulsion
4. It contains sensitizing dyes

2-5. Because of the nature of the recording medium used in still video and digital cameras, they must be loaded in complete darkness.

1. True
2. False

2-6. Exposure to light causes what invisible change to a photographic emulsion?

1. Film speed
2. Development
3. Black-metallic silver
4. Latent image

Learning Objective: Identify film characteristics that you must take into consideration when selecting a type of film for a photographic assignment.

2-7. The inherent property of a film emulsion to respond to light is known by what term?

1. Film speed
2. Spectral sensitivity
3. Exposure latitude
4. Emulsion definition

2-8. What organization is responsible for the approval of a uniform set of film-speed standards?

1. Eastman Kodak Company
2. Morgan and Morgan Corporation
3. International Standards Organization
4. Film Speed Organization of America

2-9. A film may be assigned more than one film speed for which of the following reasons?

1. Because the film may be used in hot or cold weather
2. For use with fast or slow shutter speeds
3. Because the emulsion may respond differently to different qualities of light
4. To provide the photographer with an option of shooting fast or slow subject motion

2-10. What is/are the numerical value(s) assigned to film for exposure calculation?

1. ISO
2. Exposure Index
3. Both 1 and 2
4. Light-meter Index

2-11. What does the term "spectral sensitivity" refer to in photographic emulsions?

1. The manner that the film responds to light only
2. The intensity of light required to produce the proper exposure
3. The duration of light or radiant energy required to produce a visible color image
4. The way the emulsion responds to specific colors of light and invisible radiations

2-12. Colorblind emulsions are sensitive to which of the following colors of light?

1. Blue
2. Green
3. Red
4. Yellow

2-13. Which of the following is NOT a classification of black-and white film?

1. Infrared
2. Ultraviolet
3. Panchromatic
4. Orthochromatic

2-14. Red records on an orthochromatic film in what manner?

1. As a light-blue color
2. As a dense deposit of silver
3. As a clear area
4. As a light-red color

2-15. To what type of radiation is a panchromatic emulsion NOT sensitive?

1. Infrared
2. Ultraviolet
3. Blue light
4. Green light

2-16. To prevent the exposure of infrared film by UV radiation, you should use what color filter?

1. Blue
2. Red
3. Green
4. Yellow

2-17. What areas of a black-and-white negative have the greatest amount of silver deposits?

1. Contrast points
2. Midtones
3. Highlights
4. Shadows

2-18. What term describes the amount of silver deposit present in any area of a negative?

1. Highlight
2. Contrast
3. Midtone
4. Density

2-19. What term describes the difference in densities between areas of a negative?

1. Contrast
2. Latitude
3. Emulsin definition
4. Resolving power

2-20. Which of the following definitions best describes "emulsion latitude"?

1. The ability of a film to reproduce brightness differences
2. The amount of deviation from the correct exposure that will still produce acceptable densities
3. The evenness of the emulsion thickness applied to the film base
4. The variation in film processing time that still permits the emulsion to respond to the action of the fixing bath

2-21. What is exposure latitude?

1. The difference in negative densities
2. The amount of exposure variation that will still produce an acceptable image
3. The minimum exposure required to produce sufficient shadow detail
4. The amount of density produced by a given exposure

2-22. What factor(s) determine(s) the graininess of a negative?

1. Manufacturing
2. Exposure
3. Development
4. All of the above

2-23. All processed black-and-white film produces images with metallic silver.

1. True
2. False

2-24. The ability of a emulsion to record fine detail is known by what term?

1. Clumping action
2. Resolving power
3. Acutance
4. Graininess

2-25. The ability of an emulsion to produce sharp edges between differences in density is known by what term?

1. Clumping action
2. Resolving power
3. Acutance
4. Graininess

Learning Objective: Recognize components of black-and-white and color films.

2-26. Film is protected from friction, scratches, and abrasions before development by what part of the film?

1. Overcoating
2. Base
3. Antihalation backing
4. Noncurl coating

2-27. What part of the film prevents light from reflecting back from the base and affecting the light-sensitive silver halides?

1. Overcoating
2. Emulsion
3. Antihalation backing
4. Noncurl coating

2-28. The top emulsion layer of color film is sensitive to what color of light?

1. Blue
2. Green
3. Red
4. Yellow

2-29. What is the purpose of the yellow filter incorporated between the blue and green emulsion layers of color film?

1. To enhance the contrast
2. To prevent blue light from affecting the middle and bottom emulsion layers
3. To prevent the film from being affected by UV radiation
4. To aid in printing color negatives

2-30. In a color negative, what color is the image of a red subject?

1. Blue
2. Magenta
3. Red
4. Cyan

2-31. In color-reversal film, what color is the image of a red subject?

1. Red
2. Magenta
3. Blue
4. Cyan

2-32. Daylight color film may be used without filtration under which of the following light sources?

1. Sunlight
2. Electronic flash
3. Both 1 and 2
4. "Daylight" fluorescent lights

2-33. As a Navy Photographer's Mate, you should only use a professional type of film.

1. True
2. False

2-34. Instant picture film is very useful when used in which of the following situations?

1. Passport photographs
2. Identification photographs
3. Determining test exposures
4. All of the above

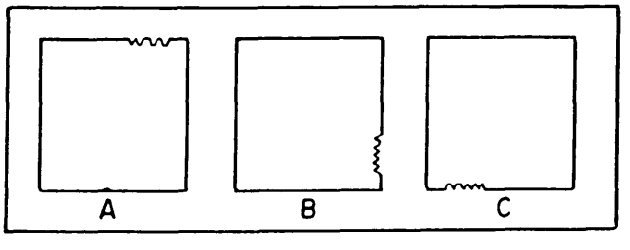


Figure 2A

IN ANSWERING QUESTION 2-35, REFER TO FIGURE 2A.

2-35. What segment(s) of figure 2A represent(s) a sheet of film with the emulsion facing you?

1. A
2. B
3. C
4. Each of the above

2-36. When images are stored on a still-video floppy disk, what mode(s), if any, provide(s) the highest quality image?

1. Frame only
2. Field only
3. Both frame and field modes provide the same image quality
4. None

2-37. What number of images can be stored on a floppy disk when used in a still-video camera set on the "field" setting?

1. 20
2. 36
3. 50
4. 100

Learning Objective: Identify characteristics of photographic papers.

2-38. When, if ever, is panchromatic printing paper used in making black-and-white prints?

1. When printing high-contrast negatives
2. When printing low-contrast negatives
3. When using color negatives to produce black-and-white prints
4. Never, panchromatic papers are only used for making color prints

2-39. The top emulsion layer of variable contrast, black-and-white paper is sensitive to (a) what color of light and produces (b) what type of contrast?

1. (a) Blue (b) high
2. (a) Green (b) low
3. (a) Blue (b) low
4. (a) Green (b) high

2-40. You are using variable contrast, black-and-white printing paper. The contrast of the print is primarily controlled by what stage of printing.

1. By different exposure times
2. By manipulating the processing time
3. By changing the angle of the projected image
4. By using filters

2-41. Which of the following color papers does NOT directly make a positive image from a color negative?

1. Ektacolor
2. Fujicolor
3. Ektachrome
4. Each of the above

2-42. The top emulsion layer of color paper produces what color of dye?

1. Red
2. Cyan
3. Blue
4. Yellow

2-43. Which of the following paper surfaces should you use to show fine detail in a print?

1. Matte
2. Semimatte
3. Pearl
4. Glossy

2-44. Photographic paper and film should be stored in a location that does not exceed what (a) temperature and (b) relative humidity?

1. (a) 75°F (b) 75%
2. (a) 50°F (b) 50%
3. (a) 75°F (b) 50%
4. (a) 50°F (b) 75%

2-45. You notice that the expiration date on a case of aerial film has expired. Which of the following actions should you take?

1. Discard the film immediately
2. Conduct photographic tests before using the film
3. Ignore the expiration date and use the film for an aerial mission
4. Freeze the film for 24 hours and then use it for Antarctic missions only

---

Learning Objective: Identify principal types of filters used in black-and-white and color photography.

2-46. What primary factor determines the effectiveness of a photographic filter?

1. The ability of the emulsion to respond to the light passed by the filter
2. The density of the filter
3. The color of the filter
4. The chemicals in which the light-sensitive emulsion is processed

2-47. It is not necessary to use color filters with black-and-white emulsions because only shades of gray are produced.

1. True
2. False

2-48. Contrast filters should be used for black-and-white photography for which of the following reasons?

1. To exaggerate a color
2. To reduce a color
3. To eliminate a color
4. Each of the above

2-49. You are tasked to copy a document on white paper that contains red, green, and blue lines. You do not want the green lines to be noticeable in the final print. What color filter should you use?

1. Magenta
2. Red
3. Green
4. Cyan

2-50. You are using black-and-white panchromatic film under daylight conditions. What color filter should you use to reproduce the colors of the scene with the same brightness relationship as seen by the human eye?

1. No. 8 (yellow)
2. No. 23A (light Red)
3. No. 34A (violet)
4. No. 4 (cyan)

2-51. You are photographing a landscape scene with black-and-white panchromatic film. Which of the following filters should you use to reduce the appearance of haze in the final print?

1. Blue
2. Cyan
3. Red
4. Magenta

2-52. Light balancing filters are available in what two colors?

1. Yellow and green
2. Green and red
3. Blue and red
4. Blue and yellow

2-53. What color of light balancing filter should you use to lower the color temperature of light?

1. Yellow
2. Green
3. Red
4. Blue

2-54. What color of light balancing filter should you use to raise the color temperature of light?

1. Yellow
2. Green
3. Red
4. Blue

2-55. What type of filter should you use to make minor adjustments to the color quality of light used to expose film?

1. Light balancing
2. Conversion
3. Color compensating
4. Correction

2-56. What instrument should you use to determine the color temperature of a light source?

1. Exposure meter
2. Color analyzer
3. Color temperature meter
4. Spot meter

2-57. What are the two series of conversion filters?

1. 80 and 81
2. 80 and 85
3. 85 and 86
4. 85 and 90

2-58. What color conversion filter is used to expose daylight-type film under tungsten light?

1. Blue
2. Green
3. Amber
4. Cyan

2-59. When exposing color film under fluorescent light, you should use what type of filter?

1. Color compensating
2. Conversion
3. Correction
4. Light balancing

2-60. What maximum number of CC filters can be used effectively on a camera lens?

1. One
2. Two
3. Three
4. Four

2-61. A CC20M filter has a peak density of 0.20 to what color of light?

1. Yellow
2. Blue
3. Magenta
4. Green

2-62. What is the complementary color of green?

1. Yellow
2. Blue
3. Cyan
4. Magenta

2-63. What combination of complementary colors make up red?

1. Yellow and cyan
2. Magenta and yellow
3. Cyan and yellow
4. Magenta and cyan

2-64. What is the equivalent filter pack of a 50G + 20R + 10B CC-filter pack?

1. 40G + 10R
2. 50G + 20R + 0 ND
3. 60G + 30R + 20B
4. 80 ND

2-65. Which of the following filters is NOT selective in the color of light it absorbs?

1. Correction
2. Neutral density
3. Color compensating
4. Conversion

2-66. What ND filter is used to reduce exposure by two f/stops?

1. .20
2. 2.00
3. .30
4. .60

2-67. What color filter is most effective for cutting haze?

1. Red
2. Yellow
3. Blue
4. Green

2-68. For which of the following situations may polarizing filters be used?

1. To reduce reflections from water
2. To reduce the effect of haze
3. To increase color saturation
4. Each of the above

2-69. Your light meter indicates an exposure of 1/500 sec at f/11. You then add an orange filter with a filter factor of 4. What is your new exposure setting?

1. 1/500 sec at f/22
2. 1/500 sec at f/8
3. 1/250 sec at f/11
4. 1/125 sec at f/11

Learning Objective: Identify the uses for filters in photographic darkrooms.

2-70. Which of the following light sources is used as a safelight in black-and-white print rooms?

1. Mercury vapor
2. Sodium vapor
3. Quartz halogen
4. Fluorescent

2-71. You have a black-and-white negative with high contrast. What color variable-contrast printing filter should you use to produce a print with normal contrast?

1. Blue
2. Green
3. Yellow
4. Magenta

2-72. Which of the following filters should always be used in a color printing system?

1. Color compensating
2. Dichroic
3. Color printing
4. Ultraviolet absorbing

2-73. What type of filter works on the principle of wavelength interference, rather than wavelength absorption?

1. Color compensating
2. Color printing
3. Safelight
4. Dichroic

2-74. CP filters are used the same as CC filters in a color printing system.

1. True
2. False

2-75. Photographic filters should not be exposed to heat above what maximum temperature?

1. 100°F
2. 120°F
3. 150°F
4. 200°F

ASSIGNMENT 3

Textbook Assignment: "Still cameras and Controls." Pages 4-1 through 4-31.

Learning Objective: Recognize similarities and differences among the various categories of cameras and the advantages and disadvantages of each.

3-1. Which of the following size cameras is most suitable for an assignment that requires a large number of exposures that must be taken in rapid succession?

1. 35mm
2. 2 1/4 x 2 3/4
3. 4x5
4. 8x10

3-2. Which of the following systems allows you to focus and compose with a picture-taking lens?

1. Rangefinder
2. TTL
3. SLR
4. PMS

3-3. On an SLR camera the focal length is fixed and cannot be changed.

1. True
2. False

3-4. What size film is used in a medium-format camera?

1. 35mm only
2. 120 only
3. 220 only
4. 120 and 220

3-5. What size of camera is most suitable for retaining maximum detail in the negative?

1. 35mm
2. 6cn x 7cn
3. 4x5
4. 8x10

Learning Objective: Identify various focusing systems and the importance of subject focus within a scene.

3-6. Which of the following focusing systems should you use when the subject must be photographed to exact scale?

1. TTL
2. Ground glass
3. SLR
4. Rangefinder

3-7. Of the following focusing systems, which one is least suitable for photographing a football game?

1. SLR
2. Rangefinder
3. Ground glass
4. Focusing scale

3-8. Which of the following focusing systems does NOT permit you to see depth of field in the viewfinder?

1. SLR
2. TLR
3. Ground glass
4. Rangefinder

3-9. As a Navy Photographer's Mate, you want everything in your photographs to be in sharp focus.

1. True
2. False

3-10. What type of focusing should you use to draw attention to the subject in a photograph?

1. Selective
2. Chosen
3. Pointed
4. Impulse

3-11. Which of the following focal-length lenses used at a given f/stop and lens-to-film distance provides the greatest selective focus affect?

1. 1000mm
2. 400mm
3. 135mm
4. 50mm

3-12. Which of the following factors does NOT affect depth of field?

1. f/stop
2. Lens focal length
3. Shutter speed
4. Subject distance

Learning Objective: Identify purpose and effects of the camera aperture.

3-13. Which of the following camera controls affects the intensity of light falling on the film plane?

1. Shutter
2. Aperture
3. Intensity compensator
4. Preview actuator

3-14. What is the most important factor in controlling depth of field?

1. Shutter speed
2. Subject distance
3. Lens focal length
4. f/stop

3-15. With a given camera and all camera controls remaining constant, what subject distance, in feet, results in the greatest depth of field?

1. 30
2. 20
3. 10
4. 5

3-16. What area of a lens produces the sharpest image?

1. The central part
2. The outer edges
3. Either 1 or 2 above

3-17. Stopping down a lens increases depth of field. In what way, if any, does this action affect image sharpness?

1. It increases overall image sharpness
2. It decreases overall image sharpness
3. None

3-18. The optimum or critical aperture of a lens is generally at what f/stop setting?

1. Wide open
2. Two f/stops from wide open
3. f/11
4. f/32

Learning Objective: Identify purpose and effects of the camera shutter.

3-19. What is the primary function of a camera shutter?

1. To limit the intensity of light emitted to the film
2. To control the quality of light passed to the film
3. To regulate the amount of time that light is permitted to act on the film
4. To stop image motion by limiting the frequency of wave motion permitted to pass through the lens

3-20. Which of the following shutter speeds can be used when a leaf shutter is used with an electronic flash?

1. 1/30 second
2. 1/125 second
3. 1/500 second
4. Each of the above

3-21. What is the primary function of the camera shutter?

1. To control the duration of exposure
2. To control subject movement
3. Both 1 and 2 above
4. To control depth of field

3-22. When increasing the camera shutter speed, you must take what action to expose the film properly?

1. Close down the aperture
2. Open up the aperture
3. Add an ND filter
4. Change the film-speed setting to a higher number

3-23. What sacrifice is made when you increase the camera shutter speed?

1. Camera movement is more apparent
2. A shorter focal-length lens must be used
3. Some depth of field is lost
4. Image sharpness

3-24. You must stop subject motion but cannot afford to loose depth of field. Which of the following actions should you take?

1. Select a faster film
2. Increase the camera-to-subject distance
3. Select a shorter focal-length lens
4. All of the above

3-25. A shutter speed of 1/250 second is required to freeze image motion acceptably. Which of the following shutter speeds can also be used to record the same image motion?

1. 1/30
2. 1/60
3. 1/125
4. 1/500

3-26. When handholding a camera with a 100mm lens, what is the slowest shutter speed you should use?

1. 1/30
2. 1/60
3. 1/125
4. 1/250

3-27. When you are photographing a moving object, which, if any, of the following shutter speeds stops image motion?

1. 1/250
2. 1/500
3. 1/1000
4. None of the above

3-28. Which of the following factors limits the time the image is allowed to move across the film plane?

1. The interval of exposure
2. The direction of subject movement
3. Subject speed
4. Lens focal length

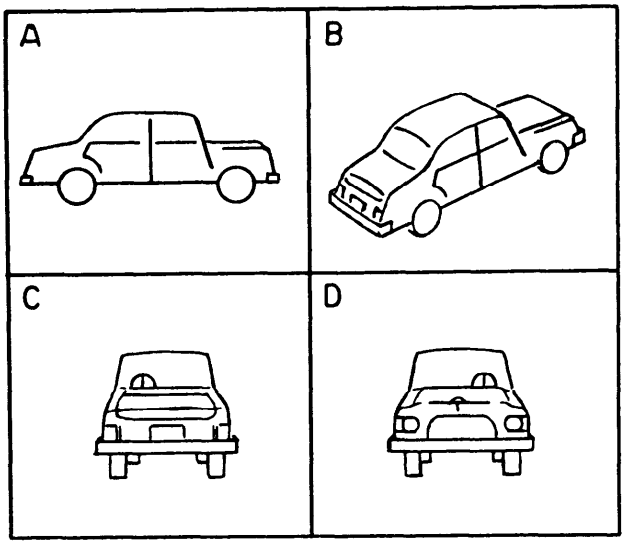


Figure 3A

IN ANSWERING QUESTION 3-29, REFER TO FIGURE 3A.

3-29. From a given camera-to-subject distance, what scene requires the fastest shutter speed to stop image movement?

1. A
2. B
3. C
4. D

Learning Objective: Recognize factors that affect the exposure of photographic film.

3-30. What two factors control camera exposure?

1. Lens speed and film speed
2. Shutter speed and lens aperture
3. Lens aperture and film speed
4. Film speed and reflected light quality

3-31. Your light meter indicates that 1/500 second at f/5.6 will properly expose the film. However, you prefer greater depth of field in the scene. Which of the following equivalent exposures should you use?

1. 1/1000 second at f/4
2. 1/250 second at f/11
3. 1/125 second at f/8
4. 1/60 second at f/16

3-32. Which of the following equations represents exposure?

1. E = I + T
2. H = E ÷ T
3. E = I x T
4. I = E x T

3-33. Your light meter indicates an exposure of 1/60 second at f/4 with Ektachrome ISO 100 film. You then change the film in the camera with Ektachrome ISO 400 film. When photographing the same subject under the same lighting conditions, which of the following camera settings should you make?

1. 1/60 second at f/5.6
2. 1/60 second at f/8
3. 1/500 second at f/4
4. 1/500 second at f/8

3-34. On a clear, bright, and cloudless day, the intensity of light remains constant.

1. True
2. False

DAYLIGHT CONDITIONS

A. Bright or hazy sun on light sand or snow

B. Bright

C. Cloudy bright

D. Cloudy

E. Heavy overcast or shade

Figure 3B

IN ANSWERING QUESTIONS 3-35 THROUGH 3-39, REFER TO FIGURE 3B AND SELECT THE DAYLIGHT CONDITION THAT BEST APPLIES TO THE STATEMENT USED AS THE QUESTION.

3-35. The type of daylight upon which basic exposure for an average scene is based:

1. A
2. B
3. C
4. D

3-36. Unobstructed daylight at the beach:

1. A
2. B
3. C
4. D

3-37. Completely diffused daylight:

1. A
2. B
3. C
4. D

3-38. Soft shadows:

1. A
2. B
3. C
4. E

3-39. The sun is not visible and eight times the basic exposure is required:

1. E
2. D
3. c
4. B

IN ANSWERING QUESTIONS 3-40 THROUGH 3-42, USE THE FOLLOWING INFORMATION: THE BASIC EXPOSURE FOR A SCENE IS 1/250 SECOND AT f/16 WITH FRONT SUN LIGHTING.

3-40. Using a shutter speed of 1/250 second, you should use which of the following f/stops when the scene is sidelighted?

1. f/4.5
2. f/5.6
3. f/8
4. f/11

3-41. Which of the following exposures can you use when the scene is backlighted?

1. l/250 at f/8
2. l/125 at f/11
3. l/60 at f/16
4. Each of the above

3-42 Which of the following exposures should you use to produce a silhouette of the scene when it is backlighted?

1. l/125 at f/32
2. l/125 at f/22
3. l/250 at f/16
4. l/250 at f/11

3-43. You are copying a chart with a 5-inch focal-length lens and a bellows extension of 10 inches. Your handheld light meter indicates an exposure of 1/60 second at f/5.6. With the aperture remaining at f/5.6, you should use what exposure time to expose the film properly?

1. l/60
2. l/30
3. l/15
4. 1/8

3-44. A 6-inch focal-length lens has a bellows extension of 16.5 inches. Your handheld light meter indicates an exposure of 1 second at f/22. What f/stop should you use to expose the film?

1. f/22
2. f/16
3. f/11
4. f/8

IN ANSWERING QUESTIONS 3-45 THROUGH 4-48, USE THE FOLLOWING INFORMATION: THE CORRECT EXPOSURE FOR A GIVEN SCENE IS 1/125 SECOND AT f/11 USING ISO 200 FILM.

3-45. Which of the following exposures should you use when the scene is photographed with ISO 100 film?

1. l/250 at f/8
2. l/250 at f/11
3. l/125 at f/8
4. l/125 at f/11

3-46. Which of the following f/stops should you use when the scene is photographed with ISO 100 film with a shutter speed of 1/250 second?

1. f/8
2. f/5.6
3. f/4.5
4. f/4

3-47. Which of the following f/stops can you use when the scene is photographed with ISO 400 film with a shutter speed of 1/125 second?

1. f/32
2. f/22
3. f/16
4. f/8

3-48. Which of the following exposures can you use when the scene is photographed with ISO 400 film?

1. 1/1000 at f/5.6
2. 1/500 at f/8
3. 1/250 at f/11
4. Each of the above

3-49. The f/16 rule for exposure calculation only applies to black-and-white photography.

1. True
2. False

Learning Objective: Identify various methods used in determining exposure with a light meter.

3-50. What means provides the most consistent way of determining film exposure?

1. Film data sheets
2. f/16 rule
3. Pocket calculator
4. Light meter

3-51. You are taking an incident light-meter reading. From what position should the light-meter reading be taken?

1. Subject
2. Camera
3. Light source

3-52. You are taking a reflected light-meter reading. You should point the camera in what direction?

1. Toward the subject
2. Toward the camera
3. Toward the light source

3-53. What type of light meter has a diffusing dome that covers the photoelectric cell?

1. Spot
2. Reflected
3. Incident
4. Inversion

3-54. You are using black-and-white film to photograph a green car. You take a reflected light-meter reading from the car. In a properly exposed and processed print, the car has what appearance?

1. Bright white
2. Middle gray
3. Dark black

3-55. You are photographing an average contrast scene and you base your camera exposure on a reflected light-meter reading from the shadow area. After it has been processed properly, the negative has what appearance?

1. Detail in the shadow areas only
2. Washed-out highlights only
3. Both 1 and 2 above
4. Very high contrast

3-56. You are taking an overall reflected light-meter reading of a subject that has almost equal areas of highlights and shadows. What type of light-meter reading are you taking?

1. Brightness range
2. Darkest object
3. Brightest object
4. Integrated

3-57. You have taken an average light-meter reading of a predominately light scene. The meter indicates an exposure of 1/250 second at f/11. Which of the following exposures should you give the film to reproduce shadow detail?

1. 1/125 at f/11
2. 1/500 at f/11
3. 1/125 at f/8
4. 1/1000 at f/5.6

3-58. You took two light-meter readings from a scene. One reading was taken from the darkest object with which you desire details and the other was taken from the lightest area where detail is desired. However, these two objects do not represent the darkest or lightest objects within the scene. What type of reflected light-meter reading did you take?

1. Integrated
2. Brightness range
3. Average
4. Substitution

3-59. You are photographing a Navy ship that is probably too distant to get an accurate light-meter reading. You then base your exposure on a gray card. What method of light-meter reading did you use?

1. Average
2. Integrated
3. Brightness range
4. Substitution

3-60. You are photographing an average scene but take a light-meter reading from a white card. You desire detail in both shadow and highlight areas. Which of the following exposure compensations should you take?

1. Close down two f/stops
2. Close down one f/stop
3. Open up two f/stops
4. Open up one f/stop

3-61. Which of the following statements regarding exposure bracketing is NOT true?

1. Bracketing is permissible for all films, both black and white and color
2. Bracketing produces varying exposures
3. Bracketing can be used but precise exposure for color slide film is required
4. Bracketing should not be used for black-and-white transparencies

3-62. You have overexposed color reversal film by one f/stop and have processed the film normally. The film has what general appearance?

1. It is very dark
2. It is washed out
3. It has more color saturation
4. It has excessive contrast

3-63. You have processed a roll of negatives normally. Each frame of the roll appears to be overexposed by one f/stop. What is the probable cause?

1. The light meter was set to the wrong ISO
2. Light entered the viewfinder while the light-meter reading was being taken
3. A very bright area of the scene influenced the light meter
4. The batteries in the light meter were too weak

Learning Objective: Recognize various functions of a view camera.

3-64. Of the following types of cameras, which one provides movements and adjustments that permit distortion correction?

1. Single-lens reflex
2. Twin-lens reflex
3. View
4. Direct-vision viewfinder

3-65. View cameras have all but which of the following parts?

1. Monorail
2. Bellows
3. Ground glass
4. Viewfinder

VIEW CAMERA CONTROL

A. Front swing

B. Rear swing

C. Front tilt

D. Rear tilt

E. Rising and falling front

F. Sliding front

G. Sliding rear

Figure 3C

IN ANSWERING QUESTIONS 3-66 THROUGH 3-71, REFER TO FIGURE 3C AND SELECT THE VIEW-CAMERA CONTROL THAT PROVIDES THE CORRECTION USED AS THE QUESTION.

3-66. Centers the image vertically:

1. C
2. D
3. E
4. F

3-67. Centers the image horizontally:

1. A
2. C
3. E
4. G

3-68. Controls distortion of the vertical plane:

1. B
2. D
3. E
4. G

3-69. Controls distortion of the horizontal plane:

1. B
2. D
3. F
4. G

3-70. Increases depth of field of the horizontal plane:

1. A
2. C
3. E
4. F

3-71. Increases depth of field of the vertical plane:

1. A
2. C
3. E
4. G

3-72. When you are initially setting up the view camera, all controls are lined up and no corrective movements are set. What is this position called?

1. Set up
2. Initial
3. Neutral
4. Starting

3-73. What total number of vertical or horizontal planes can be corrected with a view camera?

1. One
2. Two
3. Three
4. Four

Learning Objective: Recognize differences and similarities of electronic and conventional cameras.

3-74. Which of the following electronic cameras provides the highest resolution?

1. Still video
2. Digital
3. Analog
4. Each provides the same resolution

3-75. How does the angle of view of a DCS camera compare to the angle of view of a 35mm camera?

1. They are identical
2. It is less than the 35mm
3. It is greater than the 35mm

ASSIGNMENT 4

Textbook Assignment: "Basic Photographic Techniques." Pages 5-1 through 5-37.

Learning Objective: Identify general guidelines used in holding cameras steady.

4-1. What is the best way to support a camera?

1. By using a tripod
2. By handholding it
3. By holding it against a building
4. By using a neck strap

4-2. Under normal circumstances, you should NOT handhold a camera at shutter speeds that exceed what exposure time?

1. 1/500 sec
2. 1/250 sec
3. 1/125 sec
4. 1/60 sec

4-3. Holding the camera steady is most critical when using what focal-length lens?

1. 35mm
2. 50mm
3. 100mm
4. 200mm

4-4. When handholding a camera with a 250mm focal-length lens, you should use which of the following shutter speeds?

1. 1/250 sec
2. 1/125 sec
3. 1/60 sec
4. 1/30 sec

4-5. What method(s) is/arc used to prevent camera shake?

1. Locking the mirror up on an SLR camera
2. A tripod
3. A cable release
4. Each of the above

4-6. To obtain high-quality photographs, you must always use a tripod.

1. True
2. False

4-7. The use of a monopod is NOT recommended below what shutter speed?

1. 1/15 sec
2. 1/30 sec
3. 1/60 sec
4. 1/125 sec

Learning Objective: Identify elements of photographic composition.

4-8. For photographers to be creative, they must have which of the following attributes?

1. An ability to select state of the art equipment
2. An ability to handhold the camera at slow shutter speeds
3. An ability to see what the camera sees
4. An ability to selectively see only important details within a scene

4-9. Photographic composition can be improved by which of the following methods?

1. By looking all around within the viewfinder
2. By practice only
3. By analyzing photographs used in various medias
4. All of the above

4-10. A photograph should have what maximum number of center(s) of interest?

1. One
2. Two
3. Three
4. Four

4-11. Which of the following methods should you NOT use to draw viewer attention to the center of interest in a photograph?

1. Compose the subject with more than one object
2. Use a contrasting background to separate the subject
3. Place the subject in the center of the picture whenever possible
4. Use lines to draw attention to the subject

4-12. You are photographing a scene and people are included, but they are not the center of interest. The people should be composed in the photograph in what manner?

1. In the foreground only
2. Looking at the subject
3. As far from the subject as possible
4. Looking directly into the camera

4-13. Which of the following statements regarding simplicity in photographic composition is true?

1. Because of todays advanced technology, a photograph should not be simple
2. Simple pictures are monotonous and are rejected by most viewers
3. Simple pictures can be used to make a clear, strong statement
4. The most successful photographers limit simplicity by having at least two points of interest in each picture

4-14. You are photographing the CO of your ship and want him to appear in the picture as a domineering man. What camera angle should you use?

1. Low
2. High
3. Eye level

4-15. You are photographing a person who is running. What viewpoint should you use to enhance the feeling of speed?

1. Low
2. High
3. Eye level

4-16. You are photographing a refugee child. From what viewpoint should you take the picture to emphasize the illusion of little strength?

1. Low
2. High
3. Eye level

4-17. In a photograph, two objects, one on each side of the picture, appear to have equal weight. However, the picture is not symmetrical. What type of balance, if any, has been achieved?

1. Asymmetrical
2. Informal
3. Formal
4. None

4-18. A photograph shows several objects. There is an obvious difference in size and weight of the objects. However, the picture still gives the illusion of balance. What type of balance, if any, has been achieved?

1. Formal
2. Informal
3. Symmetrical
4. None

4-19. Which of the following statements concerning photographic balance is NOT true?

1. Objects in the upper part of a picture appear to have more weight than objects in the lower part of the picture
2. Objects close to the middle of a picture appear lighter than objects at the edge of the picture
3. Irregular shapes give the impression of being lighter than regular shapes
4. When an object is isolated, the weight of the object appears to decrease

4-20. In most photographs, an object within the picture is first identified by

1. weight
2. tone
3. form
4. shape

4-21. What is the three-dimensional equivalent of shape?

1. Weight
2. Tone
3. Form
4. Balance

4-22. Which of the following photographic techniques best emphasizes the shape of an object?

1. Silhouette
2. Balance
3. Texturizing
4. Three-dimensional lighting

Learning Objective: Identify methods in which lines are used for photographic composition.

4-23. Lines that lead the eye or direct attention within a photograph are known by what term?

1. Lines of direction
2. Lines of unification
3. Leading lines
4. Linear-perspective lines

LEADING LINES

A. Vertical

B. Diagonal

C. Horizontal

D. Curved

Figure 4A

IN ANSWERING QUESTIONS 4-24 THROUGH 4-36, REFER TO FIGURE 4A. SELECT THE LEADING LINE USED TO PRODUCE THE MOOD THAT IS USED AS THE QUESTION.

4-24. Strength:

1. A
2. B
3. C
4. D

4-25. Graceful movement:

1. A
2. B
3. C
4. D

4-26. Peace:

1. D
2. C
3. B
4. A

4-27. Dignity:

1. A
2. B
3. C
4. D

4-28. Action:

1. D
2. C
3. B
4. A

4-29. Rigidity:

1. A
2. B
3. C
4. D

4-30. Quietness:

1. D
2. C
3. B
4. A

4-31. Smoothness:

1. A
2. B
3. C
4. D

4-32. Grace:

1. D
2. C
3. B
4. A

4-33. Power:

1. D
2. C
3. B
4. A

4-34. Speed:

1. A
2. B
3. C
4. D

4-35. Tranquility:

1. A
2. B
3. C
4. D

4-36. Solidarity:

1. A
2. B
3. C
4. D

Learning Objective: Recognize compositional guidelines in which patterns are used for photography.

4-37. The use of patterns can provide which of the following effects in photographic composition?

1. Support of the elements within a picture
2. Add interest to the picture
3. Overwhelm the viewer
4. Each of the above

4-38. What is the most common pattern used in photographic composition?

1. Line
2. Shape
3. Color
4. Tone

4-39. What key element of composition provides apparent depth to photographs?

1. Lines
2. Shape
3. Shadows
4. Texture

Learning Objective: Identify methods used to draw viewer attention to the center of interest in a photograph.

4-40. Which of the following elements of photographic composition can you use to draw viewer attention to the center of interest?

1. Lighting
2. Texture
3. Contrast
4. All of the above

4-41. The view of a gray ship on a foggy morning is an example of what type of scene?

1. Low contrast
2. Flat
3. Both 1 and 2 above
4. Contrasty

4-42. The view of a white sailboat in dark-blue water on a clear, sunny day is an example of what type of scene?

1. Low contrast
2. Flat
3. Both 1 and 2 above
4. Contrasty

4-43. A photographic technique used to draw viewer attention to the center of interest by surrounding the subject with related objects is known by what term?

1. Keystoning
2. Framing
3. High keying
4. Desegregation

4-44. Which of the following techniques can you use to separate the subject from the foreground or background?

1. A large f/stop
2. Pan the subject
3. Move in closer to the subject
4. All of the above

4-45. What aspect of good composition is used when the viewer of a photograph gets a feeling of volume, space, depth, and distance?

1. Background
2. Foreground
3. Perspective
4. Framing

Learning Objective: Recognize various types of perspectives and how they are used in photographic composition.

TYPES OF PERSPECTIVE

A. Linear

B. Rectilinear

C. Vanishing Point

D. Height

E. Overlap

F. Dwindling Size

G. Volume

H. Atmospheric

Figure 4B

IN ANSWERING QUESTIONS 5-46 THROUGH 5-54, REFER TO FIGURE 4B. SELECT THE TYPE OF PERSPECTIVE THAT BEST APPLIES TO THE STATEMENT USED AS THE QUESTION.

4-46. Two parallel roads seem to converge in the background of the picture:

1. A
2. D
3. F
4. H

4-47. Straight, parallel, horizontal lines in the subject are recorded on the film as straight lines:

1. A
2. B
3. D
4. H

4-48. Parallel lines in a photo seem to meet outside of the picture:

1. A
2. C
3. E
4. H

4-49. The distance from the bottom of a picture where the base of an object on the ground begins:

1. D
2. E
3. F
4. G

4-50. Several objects within a photograph partly hide one another:

1. C
2. D
3. E
4. G

4-51. A number of similar objects within a photograph are shown as different sizes:

1. B
2. D
3. F
4. G

4-52. The size of objects within a photograph gives the viewer a clue as to distance:

1. A
2. C
3. E
4. F

4-53. The length of shadows provides an idea of the image size of the subject:

1. B
2. D
3. E
4. G

4-54. A photograph shows distant objects somewhat obscured by haze:

1. H
2. F
3. D
4. C

4-55. Which of the following factors affect linear perspective?

1. Lens-to-subject distance and lens focal length
2. Lens-to-subject distance and object size
3. Object size and lens focal length only
4. Object size and object-to-camera distance

4-56. What type of perspective is produced by a panoramic lens?

1. Concave
2. Cylindrical
3. Rectilinear
4. Convex

4-57. Two identical objects at different distances from the camera are recorded on film in different contrasts. This difference in contrast provides the viewer with what perception?

1. Color saturation
2. Brightness
3. Distance
4. Sharpness

Learning Objective: Identify that various lighting conditions affect the appearance of the subject.

4-58. Which of the following terms best describes color saturation?

1. Chroma
2. Brightness
3. Hue
4. Value

4-59. Which of the following statements concerning front lighting on a clear day is true?

1. It gives an impression of depth to the photograph
2. It adds a flattened effect
3. It emphasizes the texture of the subject
4. It aides in bringing out the finer details of the subject

4-60. You are tasked to photograph the flight deck of your ship after a new coat of non-skid has been applied. What time of day is best to photograph the flight deck to emphasize the texture of the newly applied non-skid?

1. 1000
2. Noon
3. 1400
4. Early morning

4-61. What type of lighting should you use outdoors to produce a silhouette photograph?

1. Back
2. Side
3. Front
4. 45 degree

4-62. You have processed a roll of daylight-balanced slide film. After removing the film from the dryer, you notice all of the frames taken indoors have a greenish cast. Which of the following light sources was most likely used to photograph the indoor scenes?

1. Electronic flash
2. Tungsten
3. Sodium vapor
4. Fluorescent

Learning Objective: Identify proper techniques used in producing images with electronic-flash units.

4-63. Which of the following factors pertaining to electronic-flash units always remains constant?

1. The f/stop being used
2. The effective candlepower seconds (ECPS)
3. The guide number
4. The film speed

4-64. What two factors are used to determine the guide number of an electronic flash?

1. ECPS and flash-to-subject distance
2. Film speed and flash-to-subject distance
3. ECPS and film speed only
4. f/stop and flash-to-subject distance

4-65. Which of the following is NOT a factor in obtaining correct exposures with an electronic flash and a lens with a leaf shutter?

1. Shutter speed
2. ISO of the film
3. Flash-to-subject distance
4. f/stop

4-66. Of the following flash techniques, which one is least desirable when you are photographing people?

1. Position the flash above the lens
2. Bounce the light from a white ceiling
3. Position the flash below the lens
4. Place diffusion material in front of the flash

4-67. Which of the following actions should you take to minimize the affect of red eye?

1. Have the subject look directly into the lens
2. Move the flash away from the lens axis
3. Move the flash closer to the lens axis
4. Reduce the ambient room light

4-68. You are using the bounce-lighting technique with an electronic flash set to “manual." The flash-to-ceiling-to-subject distance is 14 feet. The guide number of the flash is 220. What f/stop should you use to expose the film correctly?

1. f/16
2. f/11
3. f/8
4. f/5.6

4-69. You are using an electronic-flash unit. Which of the following techniques should you use to minimize distracting background shadows?

1. Hold the flash above the lens
2. Bounce the flash off the ceiling or bulkhead
3. Diffuse the light from the flash unit
4. Each of the above

4-70. What is the best general lighting ratio for both black-and-white and color photography?

1. 1:1
2. 2:1
3. 3:1
4. 5:1

4-71. You are using two flash units with the same ECPS to illuminate the subject. You should place (a) the main light and (b) the fill light at which of the following distances from the subject to achieve a 3:1 lighting ratio?

1. (a) 8 feet (b) 11 feet
2. (a) 6 feet (b) 6 feet
3. (a) 4 feet (b) 16 feet
4. (a) 4 feet (b) 8 feet

4-72. A common occurrence with the synchro-sunlight technique is it produces images of the subject that appear as though they were taken at night with a single flash unit. What is the most probable cause of this problem?

1. The flash unit was not powerful enough
2. The flash illumination overpowered the sunlight
3. The aperture used was too wide
4. The lens was not synchronized with the flash unit

4-73. What is the first step in calculating synchro-sunlight exposure?

1. Determine the correct daylight exposure
2. Determine the desired flash-to-subject distance
3. Establish the camera-to-subject distance
4. Establish the camera-to-flash distance

4-74. You are using an electronic flash unit to light a subject 20-feet away at night. The indicated f/stop on the flash unit is f/11. What f/stop should you use to expose the subject?

1. f/16
2. f/11
3. f/8
4. f/5.6

4-75. You are using two flash units of equal intensity that are equidistant from the subject to illuminate the same area of the subject. The calculated f/stop for one flash unit is f/16. What f/stop should you use to expose the image?

1. f/11
2. f/16
3. f/22
4. f/32

ASSIGNMENT 5

Textbook Assignment: "Photographic Assignments." Pages 6-1 through 6-44.

Learning Objective: Select equipment and techniques best suited for photographing people.

5-1. Which of the following statements will best determine your success as a Navy Photographer's Mate?

1. Use only state-of-the-art equipment
2. Plan for each of your assignments
3. Use professional film only
4. Use a 4x5 view camera for the majority of your photographic assignments

5-2. The UIC of your imaging facility is 32509. Which of the following serial numbers best represents a local serial number for a camera assigned to your unit?

1. L-069
2. L/S 32509-069
3. 069-L-32509
4. 32509-069

5-3. When photographing people, you should strive to achieve which of the following objectives?

1. Display the subject's character
2. Identify the person clearly only
3. Exaggerate the facial features of the subject
4. Always portray the subject in a pleasing, flattering manner

5-4. For you to make a candid photograph of a person, the subject must not know that his/her photograph is being taken.

1. True
2. False

5-5. You should normally select which of the following lenses for a 35mm camera to shoot candid photographs?

1. Fisheye
2. 35mm
3. 50mm
4. 135mm

5-6. Which of the following statements regarding the technique of framing people in their environment is true?

1. The "frame" should be a subtle part of the photo
2. The "frame" should be exaggerated
3. The "frame" must completely surround the subject
4. The "frame" should be in front of the subject

5-7. You are photographing people working in their environment. Which of the following aspects of the finished product is extremely important?

1. The face of the subject must be in full view
2. The subject must be actually working
3. The props used in the photograph must be technically correct
4. A low angle should be used to portray the person in power

5-8. In a formal group picture, attention must not be drawn to any one individual in the photograph. However, in an informal group photograph, attention should be drawn toward the most senior member of the group.

1. True
2. False

5-9. You are taking a formal group photograph of eight people. You should arrange them in a total of how many rows?

1. One
2. Two
3. Three
4. Four

5-10. You are making a formal group picture of an admiral's staff. The staff consists of the admiral, three captains, seven commanders, two lieutenants, and three CPOs. The admiral should be placed in what location for the picture?

1. On the far right end of the first row
2. In the center of the back row
3. In the center of the middle row
4. In the center of the first row

5-11. Which of the following elements of a group photograph is the most difficult to control?

1. The viewpoint
2. The composition
3. The people
4. The distracting background

5-12. To take action photographs successfully, you should perform which of the following actions?

1. Anticipate the action
2. Know the photographic equipment being used
3. Learn something about the action
4. All of the above

5-13. Action should always be photographed at what time?

1. At the peak
2. Directly after the peak
3. Immediately before the peak

5-14. You are photographing the Secretary of the Navy presenting a Purple-Heart Medal to an Airman Recruit. Your battle group flag officer and your CO are also involved in the award ceremony. What person should you concentrate on as the center of interest?

1. Secretary of the Navy
2. Admiral
3. Commanding Officer
4. Airman Recruit

Learning Objective: Recognize basic principles of caption writing.

5-15. Which of the following elements is NOT a basic requirement in caption writing?

1. Explanation
2. Identification
3. Credit line
4. Background information

5-16. In a picture caption, what sentence is most important?

1. First
2. Middle
3. Last
4. Closing

5-17. When you are writing captions, they should always be written in what (a) voice and (b) tense?

1. (a) Passive (b) past
2. (a) Active (b) past
3. (a) Passive (b) present
4. (a) Active (b) present

5-18. The amount of background information included in a caption is determined primarily by which of the following factors?

1. The way the final picture is to be used
2. The location in which the final picture is to be used
3. Both 1 and 2 above
4. The ethnic background of the subject

CAPTION WRITING ELEMENTS
A. What
B. Where
C. When
D. Why
E. How

Figure 5A

IN ANSWERING QUESTIONS 5-19 THROUGH 5-22, SELECT THE CAPTION WRITING ELEMENT THAT BEST APPLIES TO THE STATEMENT USED AS THE QUESTION.

5-19. Testing squadron readiness:

1. A
2. B
3. D
4. E

5-20. During July and September:

1. E
2. C
3. B
4. A

5-21. Falling in for muster:

1. A
2. B
3. C
4. D

5-22. On board the USS *Lincoln:*

1. D
2. c
3. B
4. A

5-23. When following the general guidelines for caption writing, you should limit the words to what number?

1. 12
2. 25
3. 50
4. 100

5-24. What element is the most important part of caption writing?

1. Explaining the action
2. Caption length
3. Identifying principal subjects
4. Credit line

5-25. Of the four methods of identifying persons in writing a caption, what method is best?

1. Obvious contrast
2. Elimination
3. From the left
4. Action

5-26. What is the least desirable method of identification used in caption writing?

1. From the left
2. Elimination
3. Obvious contrast
4. Action

Learning Objective: Recognize methods used for investigative photography.

5-27. When photographing a scene as part of an investigation, you should always include which of the following items?

1. The investigative team
2. An overall shot of the scene
3. Close-up photographs of each object in the scene
4. Fingerprints

5-28. You are assigned to take photographs for an investigation. You trip accidentally and knock over several items. Which of the following actions should you take?

1. Photograph the items as they now appear
2. Rearrange the objects as they were and then photograph them
3. Inform the investigative team of your accidental act
4. Say nothing unless asked

5-29. Using color film to photograph the scene of a fire has what primary advantage over black-and-white film?

1. It can be processed faster
2. It records finer detail
3. It can assist in identifying the types of materials being burned
4. It records blackened and charred objects better

5-30. You are taking photographs of a burned-out building. Your basic flash exposure indicates an exposure of f/11. Which of the following aperture settings should you use?

1. f/16
2. f/11
3. f/8
4. f/5.6

5-31. What is the primary purpose of aircraft-accident photography?

1. To identify the person(s) at fault
2. To prevent future accidents
3. To establish the primary cause of the accident
4. To provide photographs for safety grams

5-32. What type of information is NOT required on photographs of an aircraft accident?

1. Type of aircraft
2. Date of accident
3. Name of pilot(s)
4. Type of accident

Learning Objective: Select equipment and methods used in product photography.

5-33. When used properly, which of the following cameras provides the best results when you are photographing small parts in a studio?

1. 35mm SLR
2. Medium-format SLR
3. Medium-format TLR
4. 4x5 view

5-34. The most effective main light for product photography is provided by which of the following light sources?

1. Spotlight
2. Floodlight
3. Fluorescent bulbs
4. Plane reflectors

5-35. In product photography, where is the main light generally located?

1. High and in front of the subject
2. Beiow and to the side of the subject
3. High and behind the subject
4. Directly above the subject

5-36. In product photography, the subject should appear as though it is illuminated by what number of light source(s)?

1. One
2. Two
3. Three
4. Four

5-37. In the studio, which of the following types of lighting can be used to simulate the light from an overcast sky?

1. Spot
2. Tent
3. Key
4. Flood

5-38. When establishing the lighting for a product, you should view the subject from what position?

1. The main light
2. The fill light
3. Above the subject
4. The camera

5-39. What type of lighting is used to emphasize the texture of a product?

1. Tent
2. Fill
3. Cross
4. 45 degree

5-40. You are using color film for product photography. The areas between the highlights and shadows where you want to record detail should not exceed what number of f/stops?

1. Seven
2. Six
3. Five
4. Four

5-41. Your light meter indicates an exposure of 7 seconds at f/8. What is your exposure using the painted light technique?

1. 7 seconds at f/8
2. 14 seconds at f/4
3. 14 seconds at f/8
4. 21 seconds at f/8

5-42. When using the painted-light technique, you should use what minimum exposure time?

1. 5 seconds
2. 10 seconds
3. 20 seconds
4. 25 seconds

5-43. You are using a mirror to photograph a broken fitting in the wheel well of an aircraft. The broken fitting-to-camera distance is 27 inches, the mirror-to-fitting distance is 19 inches, and the camera-to-mirror distance is 33 inches. What focusing distance, in inches, should you set on the camera lens?

1. 79
2. 60
3. 52
4. 46

5-44. You are photographing an arrangement of glassware in the studio using color negative film. Your light-meter reading taken from the background indicates an exposure of 4 seconds at f/16. While at f/16, you should use which of the following camera settings to expose the film?

1. 16 seconds
2. 12 seconds
3. 8 seconds
4. 4 seconds

5-45. You are photographing an object in the studio and are using a continuous-tone film (ISO 100) and a high-contrast film (ISO 8) to eliminate an unwanted background. Your exposure for the continuous-tone film is 24 seconds at f/16. What f/stop should you use to expose the slow, high-contrast film?

1. f/16
2. f/11
3. f/8
4. f/5.6

Learning Objective: Recognize equipment and techniques used for photographing buildings and structures.

5-46. What type of camera is best suited for photographing architectural structures?

1. 35mm SLR
2. Medium-format TLR
3. Medium-format SLR
4. View camera

5-47. You are tasked to photograph a new Navy Lodge on board a local NAS. Which of the following weather conditions should you avoid when taking this photograph?

1. Bright day with clear skies
2. Slightly overcast day
3. Cloudy day
4. Bright day with large, puffy clouds

5-48. You are tasked to photograph the interior of a building that has a number of large windows. What time of day should you make the exposures?

1. Early Morning
2. Mid Morning
3. Noon
4. After dark

5-49. A lens shade should always be used over camera lenses.

1. True
2. False

Learning Objective: Identify basic principles used in intelligence-gathering photography.

5-50. What black-and-white film is best suited for taking intelligence-gathering pictures?

1. Kodak Tri-X
2. Kodak Tech Pan
3. Ilford XP-1
4. Kodak Plus-X

5-51. What color film is best suited for taking intelligence-gathering pictures?

1. Kodak Gold
2. Kodak Ektar
3. 3M HR
4. Kodak Vericolor Professional

5-52. Because the resolution of videotape is inferior to film, it should not be used for intelligence-gathering purposes.

1. True
2. False

5-53. What type of shot is most helpful to analysts in determining the overall dimensions of a ship?

1. Starboard beam
2. Stern
3. Port quarter
4. Bow

5-54. Which of the following light-meter reading techniques should you use to photograph an aircraft that is airborne?

1. Integrated
2. Brightest object
3. Incident
4. Substitution

5-55. Intelligence photographs of foreign ports are seldom taken from Navy ships because an ample supply of these images are provided by satellites.

1. True
2. False

ASSIGNMENT 6

Textbook Assignment: "Portraiture." Pages 7-1 through 7-20.

Learning Objective: Identify proper equipment and techniques used in photographing portraits.

6-1. A portrait should emphasize which of the following aspects about a person?

1. Their environment
2. A recognizable likeness only
3. Their personality
4. Their flattering characteristics only

6-2. Which of the following factors can help you succeed in portrait photography?

1. An understanding of the techniques involved
2. An artistic ability
3. The ability to direct subjects
4. All of the above

6-3. What is/are the most important feature(s) of the face?

1. Nose
2. Eyes
3. Mouth
4. Ears

6-4. What is/are the most expressive feature(s) of a face?

1. Eyes
2. Mouth
3. Cheeks
4. Forehead

6-5. You are using a camera that produces a 6x7 cm negative to shoot a head-and-shoulders portrait. Which of the following lenses should you use?

1. 50mm
2. 75mm
3. 150mm
4. 250mm

6-6. What type of background is best suited for official Navy portraits?

1. Bright colored
2. Light, neutral colored
3. Dark colored
4. Glossy surfaced

6-7. Your studio is set up with a brightly colored background and you are shooting color film for a portrait session. What is/are the disadvantage(s) of using this colored background?

1. It can distract from the subject
2. Reflected light may affect the tone of the subject's face
3. It may alter the mood you want to represent
4. Each of the above

6-8. As a minimum, what two colors of backgrounds available should a Navy portrait studio have?

1. White and gray
2. Black and gray
3. Black and white
4. Gray and black

Learning Objective: Select various lighting sources and accessories used in portrait photography.

6-9. What light source is best for portrait photography?

1. Sunlight
2. Daylight
3. Incandescent light
4. Electronic flash

6-10. You want to produce deep, well-defined shadows on the face of a portrait. What type of light source should you use?

1. Reflected light
2. Spotlight
3. Floodlight
4. Diffused light

6-11. The technique that allows only the softer, outer part of a light beam to fall on the subject is known by what term?

1. Diffusing
2. Snooting
3. Feathering
4. Spotting

6-12. Which of the following lighting accessories is used to soften specular light?

1. Fresnel lens
2. Barn door
3. Snoot
4. Diffusers

6-13. What lighting accessory is used to feather light?

1. Snoot
2. Barn door
3. Diffuser
4. Umbrella

6-14. What lighting accessory is used to control spill light?

1. Barn door
2. Diffuser
3. Umbrella
4. Reflector

6-15. What lighting accessory is used to control the size of the light beam falling on the subject?

1. Barn door
2. Snoot
3. Diffuser
4. Umbrella

6-16. What lighting accessory is used to spread light over a larger area than that provided from the original source?

1. Barn door
2. Snoot
3. Diffuser
4. Umbrella

Learning Objective: Identify camera- and subject-handling techniques used in portrait photography.

6-17. What type of black-and-white film should you use to emphasize the texture of a man's skin in a portrait?

1. Panchromatic
2. Colorblind
3. Orthochromatic
4. Infrared

6-18. Which of the following f/stops is generally better suited for taking portraits?

1. f/8
2. f/16
3. f/32
4. f/64

6-19. Portrait appointments should be scheduled no closer than how many minutes apart?

1. 5
2. 10
3. 15
4. 20

6-20. People should generally have their portraits taken during what part of the day?

1. Morning
2. Afternoon
3. Evening
4. Night

6-21. Which of the following methods helps to provide a natural expression of the subject?

1. Tell them to "just act natural"
2. Show them an example of how you want them to look
3. Carry on a conversation with the subject to help them feel at ease
4. Tell a joke at the time of exposure

6-22. When directing the subject for a portrait pose, you, as the photographer, should be in what location?

1. Behind the camera
2. At the subject's side
3. Behind the subject
4. In front of the camera within the circle of light

6-23. What is the best average height of a camera for a head-and-shoulders portrait?

1. Chest level
2. Slightly above the subject’s eyes
3. Slightly below the subject's chin
4. Nose level

6-24. When shooting a full-length portrait, you should begin with your camera at what level to the subject?

1. Waist
2. Chest
3. Shoulder
4. Head

6-25. You are shooting a portrait and want the subject to appear to be looking, but not staring at the viewer in the finished print. To create this effect, you should have the subject look in what direction during the camera exposure?

1. Into the camera lens
2. Slightly above the camera lens
3. Below the camera lens
4. At the modeling light

6-26. To create the feeling of motion in a head-and-shoulders portrait, you should have the subject sit in what position in relation to the camera?

1. At an angle and leaning slightly forward
2. At an angle and leaning slightly backward
3. Square and leaning slightly forward
4. Square and leaning slightly backward

6-27. What is the point of interest in a military portrait?

1. The national ensign
2. The subject's rank or rating insignia
3. The subject's awards
4. The subject's face

Learning Objective: Recognize different types of portrait lighting and their corresponding effects.

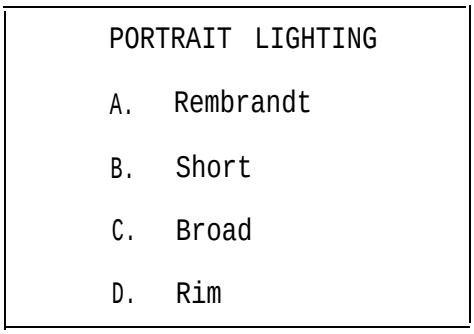


Figure 6A

IN ANSWERING QUESTIONS 6-28 THROUGH 6-31, REFER TO FIGURE 6A AND SELECT THE TYPE OF PORTRAIT LIGHTING USED TO CREATE THE EFFECT USED AS THE QUESTION.

6-28. The side of the face away from the camera is fully lighted:

1. A
2. B
3. C
4. D

6-29. The side of the face away from the camera is lighted by a high main light:

1. A
2. B
3. C
4. D

6-30. The entire face is in shadow:

1. A
2. B
3. C
4. D

6-31. The side of the face toward the camera is well-lighted:

1. A
2. B
3. C
4. D

6-32. What type of lighting produces a shadow directly under the nose?

1. Broad
2. Butterfly
3. Short
4. Rembrandt

6-33. What type of lighting is used to illuminate one side of the face while placing the opposite side completely in shadow?

1. Rim
2. Short
3. Split
4. Broad

Learning Objective: Identify methods used to determine the placement of portrait lights.

6-34. What light source in a portrait-lighting situation is the most influential?

1. Fill
2. Hair
3. Background
4. Modeling

6-35. In military portraits, what type of lighting is used for subjects with a normal shape face?

1. Short
2. Broad
3. Butterfly
4. Spit

6-36. What type of lighting should you use for a subject with a narrow face?

1. Short
2. Broad
3. Spit
4. Rembrandt

6-37. Which of the following lighting effects causes too much light to be reflected from the subject's forehead in a portrait?

1. The fill light is too bright
2. The main light is too far from the fill light
3. The main light is too close to the subject
4. The intensity of the fill light is greater than the main light

6-38. What light creates the facial highlights in portrait lighting?

1. Background
2. Hair
3. Fill
4. Main

6-39. What factors are used to determine the required direction of the main light in three-quarter portrait lighting?

1. The distance of the main light from the fill light
2. The size and shape of the subject's nose
3. The size and intensity of the main light as compared to the fill light
4. The relationship of the nose shadow to the upper lip

6-40. What facial highlight is used to determine the distance of the main light?

1. Nose
2. Forehead
3. Chin
4. Cheek

6-41. When naval officers have their portrait made with their cover on, the shadow cast by the visor must not fall across their eyes.

1. True
2. False

6-42. What is the purpose of the fill light in portrait lighting?

1. To provide shadow detail
2. To increase the level of illumination necessary to obtain greater depth of field
3. To provide modeling and highlight contrast
4. To increase the lighting ratio

6-43. In three-quarter portrait lighting, the fill light should be in what location?

1. Directly behind the main light
2. On the same side of the camera as the main light
3. On the opposite side of the camera from the main light
4. Behind the subject

6-44. The shadow cast under the subject's chin by the fill light helps to separate the head from the neck in portrait lighting, and therefore should be quite dark.

1. True
2. False

6-45. In a portrait subject's eye, what is the small reflection caused by the main light called?

1. Highlight
2. Star light
3. Bright light
4. Catch light

6-46. What number of catch lights should be in each eye?

1. One
2. Two
3. Three
4. Four

6-47. In broad lighting, the catch light should be in what approximate position?

1. One o'clock
2. Six o'clock
3. Three o'clock
4. Eleven o'clock

6-48. In short lighting, the catch light should be in what approximate position?

1. One o'clock
2. Six o'clock
3. Three o'clock
4. Eleven o'clock

6-49. What is the maximum lighting ratio for color portraits?

1. 1:1
2. 2:1
3. 3:1
4. 5:1

6-50. In portrait lighting, what light is used to provide tonal separation between the subject and the background?

1. Main
2. Catch
3. Fill
4. Background

6-51. You are shooting a color portrait for a command roster board. To reproduce the background in its true color, you should ensure what amount of incident light is falling on it?

1. The same as the subject
2. Twice as much as the subject
3. One half as much as the subject
4. Four times as much as the subject

6-52. You position the background light so the illumination falls off gradually into the corners of the frame. This produces what effect?

1. It hides uneven borders
2. It provides image balance
3. It "locks" the image into the frame
4. It helps direct attention to the subject's face

6-53. Light-meter readings for portraits should be taken with the hair light turned off.

1. True
2. False

6-54. When setting up a portrait using side lighting, you should start with the main light in what position?

1. Very close to the lens axis
2. 45 degrees from the lens axis
3. 90 degrees from the lens axis
4. 180 degrees from the lens axis

6-55. What type of portrait lighting should you use to subdue lines and wrinkles in the subject's face?

1. Spit
2. Broad
3. Butterfly
4. Rembrandt

6-56. What facial shadow should you use to determine the height of the main light for butterfly lighting?

1. Eyebrow
2. Nose
3. Lip
4. Chin

6-57. You are taking a portrait of a female admiral using butterfly lighting. In what position should you place the fill-in light?

1. Close to the lens axis and on the opposite side from the main light
2. 45 degrees from the lens axis and on the same side as the main light
3. 45 degrees from the lens axis and on the opposite side of the main light
4. Directly below the main light and close to the lens axis

Learning Objective: Identify the basic setup used for taking full-length portraits.

6-58. What background color is best suited for a full-length portrait of an officer wearing khakis?

1. Gray
2. Light blue
3. Beige
4. White

6-59. You are taking a full-length officer promotion portrait of a CDR. You should pose the subject in what manner?

1. Square to the camera
2. Facing your left
3. Three quarters with the left shoulder forward
4. One that makes him appear thin

6-60. Because all military portraits are standardized, they should be taken with the same pose, camera height, and lighting setup.

1. True
2. False

Learning Objective: Identify corrective techniques used in portrait photography.

PORTRAIT PROBLEM AREAS

A. Protruding lips

B. Glasses

C. Baldness

D. Fat, round face

E. Deep-set eyes

F. Wide forehead

Figure 6B

IN ANSWERING QUESTIONS 6-61 THROUGH 6-66, REFER TO FIGURE 6B AND SELECT THE PORTRAIT PROBLEM AREA THAT BEST MATCHES THE CORRECTIVE ACTION USED AS THE QUESTION.

6-61. Low-camera viewpoint and front-lighting:

1. B
2. C
3. D
4. E

6-62. Shoot three-quarter view. Short or sidelighting:

1. A
2. C
3. D
4. F

6-63. Low main light:

1. A
2. B
3. D
4. F

6-64. Low-camera viewpoint. Light to blend head with background:

1. B
2. C
3. D
4. F

6-65. High, three-quarter or front-lighting. Tilt head downward:

1. A
2. B
3. C
4. E

6-66. Low-camera viewpoint. Tilt chin upward:

1. A
2. B
3. D
4. F

6-67. Film exposure for portraits should be based on the intensity of

1. the fill light only
2. the main light only
3. the fill and main lights only
4. all lights used

Learning Objective: Recognize principles used for taking passport photographs.

6-68. All active-duty military personnel are entitled to no cost tourist passport photographs taken in Navy imaging facilities.

1. True
2. False

6-69. The head size for passport photographs must be what size, in inches?

1. 1 to 1 3/8
2. 1/2 to 1
3. 3/4 to 1 1/4
4. 1 3/8 to 2

6-70. A Navy lieutenant enters your imaging facility for a passport photograph wearing prescription aviator sunglasses. He normally wears glasses but does not have glaucoma. Which of the following actions should you take?

1. Ask him to put on his regular glasses and then take the photograph
2. Have him remove the sunglasses and take the photograph
3. Say nothing and take the photograph with the sunglasses on

ASSIGNMENT 7

Textbook Assignment: "Copying" and "Chemical Mixing." Pages 8-1 through 9-12.

Learning Objective: Recognize different types of copy originals.

COPY TERMS
A. Line Originals
B. Reproduction
C. Halftone
D. Continuous-Tone Original
E. Duplication

Figure 7A

IN ANSWERING QUESTIONS 7-1 THROUGH 7-4, SELECT THE COPY TERM THAT BEST APPLIES TO THE DEFINITION USED AS THE QUESTION.

7-1. A photograph comprised of many different gray, white, and black tones:

1. A
2. B
3. D
4. E

7-2. The product of copying:

1. A
2. B
3. C
4. D

7-3. A black-and-white printed page:

1. A
2. B
3. C
4. D

7-4. A picture made of various size dots:

1. A
2. B
3. C
4. D

Learning Objective: Identify conditions of copyrighted materials.

7-5. Copyright laws apply only to works published and made available for sale.

1. True
2. False

7-6. To play it safe as a Navy Photographer's Mate, you should abide by which of the following rules regarding copyright information?

1. Never copy information that is copyrighted
2. You may copy any copyrighted material if it will be used one time only and the copy is marked "For Official Use Only"
3. Be sure permission from the copyright holder is obtained before copying copyrighted materials
4. If it is used for training purposes, it may be copied

7-7. Which of the following items may be copyrighted?

1. Compact disks
2. Videotapes
3. Photographs
4. Each of the above

7-8. At what point in time does a photograph legally become copyrighted?

1. When it is processed
2. When it is submitted to the Copyright Office
3. When it is published
4. When it is sold

7-9. Which of the following statements regarding copyright is true?

1. A notice of copyright is marked conspicuously on all copyrighted documents
2. Although a publication does not carry a notice of copyright, it may still be copyrighted
3. Without permission from the copyright owner, you may still copy publications from foreign countries
4. All of the above

7-10. A literary work was created by two authors in 1980. Neither of the authors worked for hire. The first author died in 1981, and the second author died in 1885. What year does the copyright expire for this work?

1. 2031
2. 2035
3. 2056
4. 2085

7-11. What, if anything, is meant by "international copyright?"

1. The material is copyrighted throughout the world
2. The copyright applies to UCC countries only
3. All UCC countries have agreed to copyright the material
4. There is no such thing as "international copyright"

7-12. A Navy pilot takes some air-to-air photographs of an aircraft just introduced to the fleet. As assistant PAO, this is a part of his duty. These photographs are copyright protected for what length of time, if any?

1. 50 years after his death
2. 75 years after his death
3. 100 years from the date the photographs were processed
4. None

7-13. Which of the following statements concerning copyright information and the principle of "fair use" is NOT true?

1. For educational purposes, a teacher can make a single copy of a document for each student and use the copies from year to year
2. A single copy of an article from a magazine may be used for research purposes
3. There is no limit to the number of copies that can be made of a table of weights and measures
4. A teacher may make a single copy of a chapter in a book if the material is used in preparation for teaching a class

7-14. What instruction provides information on the use of copyrighted material for official Navy use?

1. OPNAVINST 5290.1
2. SECNAVINST 5870.5
3. SECNAVINST 5216.5
4. COPYRITINST 10700.3

7-15. You are standing "duty PH" alone at a base imaging facility. The CO of the base personally brings in a copyrighted document that he needs copied to a 35mm slide at once. What action should you take?

1. Tell the CO you cannot copy the document because it is copyrighted
2. Mask the copyright notice, then copy the document
3. Ensure the CO knows that the document is copyrighted before you begin the job
4. Make an extra slide of the document and forward it to the CNO

7-16. It is illegal to photograph United States currency.

1. True
2. False

Learning Objective: Recognize equipment, film, and lighting techniques used for photographic copying.

7-17. For an imaging facility that performs a large quantity of copy work, what focusing system is best?

1. SLR
2. Rangefinder
3. Ground glass
4. Split level

7-18. What is the minimum desired bellows extension for a copy camera?

1. The lens focal length
2. Twice the lens focal length
3. Three times the lens focal length
4. Four times the lens focal length

7-19. What type of lens is designed specifically for copying?

1. Process
2. Convertible
3. High resolve
   Two dimensional

7-20. What primary factor determines the focal-length lens you should use for copy work?

1. The lens-to-original distance
2. The size of the original
3. The distance from the light source to the original
4. The size of the negative

7-21. For copy work, you should use which of the following lenses, in inches, on a camera that produces an 8x10-inch negative?

1. 8
2. 10
3. 12
4. 18

7-22. The copyboard of a copy camera should not be white or a light color for which of the following reasons?

1. The film will be overexposed
2. The film will be underexposed
3. The reproduced image will lack good contrast
4. The reproduced image will have excessive contrast

7-23. What is the color temperature rating of tungsten lamps?

1. 3200 K and 3400 K
2. 5400 K and 7200 K
3. 7400 K and 9600 K
4. 10,000 K and 21,000 K

7-24. What is the approximate lifetime, in hours, of a 3400 K lamp?

1. 5
2. 9
3. 3
4. 34

7-25. What type of light source is best suited for copying a painting with rough surface?

1. 3200 K tungsten lamp
2. Fluorescent lamp
3. Electronic flash
4. Quartz-halogen lamp

7-26. You are copying charts to 35mm color slides on an MP-4 copy camera. The right-rear lamp burns out. What lamp(s) should you replace?

1. The right-rear lamp only
2. The right-rear and the right-front lamps only
3. The right-rear and the left-rear lamps only
4. All four lamps

7-27. What type of film should you use to copy a black-and-white line original?

1. Kodalith
2. Plus-X
3. HP5 Plus
4. XP2

7-28. Which, if any, of the following types of film should you use to make a black-and-white copy of a colored line original?

1. Colorblind
2. Orthochromatic
3. Panchromatic
4. None of the above

7-29. To copy a black-and-white continuous-tone original, you should use which of the following films??

1. Kodalith
2. Contrast Process Pan
3. Kodak Commercial
4. Tri-X

7-30. Which of the following films should you use to produce a color negative of a color photographic print?

1. Vericolor III Professional
2. Kodak Internegative
3. Ektachrome
4. Kodacolor

7-31. You are printing a number of color prints that will later be copied to color slides. What surface paper should you use to make the prints?

1. Glossy
2. Matte
3. Semimatte
4. Pearl

7-32. At what angle to the original should the copy lights be positioned for general, routine copy work?

1. 90°
2. 45°
3. 30°
4. 10°

7-33. You have produced a copy negative that you know was lighted evenly, but the negative still has less density at the edges than at the center. What factor most probably caused this problem?

1. A wide-angle lens was used
2. A telephoto lens was used
3. The film was overexposed
4. The film was underexposed

7-34. What type of film requires the most critical exposure?

1. High contrast
2. Moderate contrast
3. Normal contrast
4. Low contrast

7-35. Many bright reflections are occurring from high points of brush strokes on an oil painting that you are copying. What may be the end result?

1. Increased contrast
2. Reduced contrast
3. Underexposure
4. Overexposure

7-36. Polarizing screens are being used over copy lights. Approximately how much of an increase in exposure is required as compared to using the lights unscreened?

1. 5 times
2. 2 times
3. 12 times
4. 20 times

7-37. You are using an ISO 100 speed film to make copies. Your exposure meter reading is taken from an 18-percent gray card. What ISO speed should you set into the meter?

1. 25
2. 50
3. 100
4. 200

7-38. You are producing copies using a 14-inch bellows extension. The lens focal length is 6 inches and the indicated exposure is 3 seconds. What exposure time, in seconds, should you use?

1. 6
2. 12
3. 16
4. 32

7-39. When photographing images of a CRT, you must be aware of which of the following requirements?

1. The shutter speed is extremely critical when photographing radarscopes
2. The screen brightness must be adjusted to maximum so the brightest possible images are provided
3. To shoot a computer monitor, you must set the camera shutter speed to 1/250 second
4. The optical axis of the lens must be centered and perpendicular to the monitor

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Learning Objective: Identify methods used to duplicate slides.

7-40. For slide duplication, what side of the film should face the camera?

1. Emulsion
2. Base

7-41. You have copied a number of slides and all of the processed images on the roll are extremely yellow. What action should you take first?

1. Subtract 50Y from the filter pack
2. Add 50B to the filter pack
3. Add 50M and 50C to the filter pack
4. Check the duplicating system to ensure the CC filters were in the proper position when the slides were exposed

7-42. When trying to determine the color correction necessary for a duplicate color slide, you should examine what tones?

1. Midtones
2. Shadows
3. Highlights

7-43. By viewing a color slide through a CC10R filter, you determined that the color looks correct. Which of the following adjustments should you make to your filter pack?

1. Subtract CC10R only
2. Subtract CC10M and CC10Y
3. Add CC10C only
4. Subtract CC10C only

Learning Objective: Identify proper mixing and storage procedures for photographic chemicals.

7-44. What is the most important reason for ensuring that photographic chemicals are mixed properly?

1. using improperly mixed chemicals is always hazardous to the user's health
2. Improperly mixed chemicals may ruin the film from an important mission
3. The mixing equipment may be damaged

7-45. The storage of unmixed chemicals should be at what approximate temperature and relative humidity, respectively?

1. 20°F; 68 percent
2. 40°F; 75 percent
3. 68°F; 20 percent
4. 75°F; 40 percent

7-46. Containers made from what material are best for storing liquid developer?

1. Hard rubber
2. Plastic
3. Glass
4. Stainless steel

7-47. Air space should never be left in a large bottle used for storing developer replenisher.

1. True
2. False

7-48. Floating lids are used for storage of large volumes of solution in tanks for what primary purpose?

1. To prevent dust from settling on the surface of the solution
2. To prevent water in the solution from evaporating
3. To prevent unauthorized use of the solution
4. To protect the solution from aerial oxidation

7-49. Which of the following materials is NOT suitable for a photographic chemical storage tank?

1. Aluminum
2. Glass
3. 316 Stainless Steel
4. Polyethylene

7-50. When washed well between uses, wooden paddles make excellent chemical mixing tools.

1. True
2. False

7-51. The curved surface at the top of a solution is known by what term?

1. Convexation
2. Concavation
3. Meniscus
4. Mantissa

7-52. An increase in temperature has what effect, if any, on chemical action?

1. It increases
2. It decreases
3. None

Learning Objective: Identify items of equipment used in Navy imaging facilities to test or verify chemical solutions.

7-53. What instrument is used to measure the specific gravity of a solution?

1. Densitometer
2. pH meter
3. Hydrometer
4. Thermometer

7-54. The specific gravity measurement of a solution is below the lower limit. This may be an indication of which of the following errors?

1. The solution is diluted with too much water
2. Not enough water was added
3. Too much of an ingredient has been added
4. The solution may be highly acidic

7-55. A hydrometer used to measure the silver content of a fixing bath is calibrated in grams of silver per

1. ounce
2. milliliter
3. gallon
4. liter

7-56. Specific gravity is a measurement of what property of a liquid?

1. Composition
2. Strength
3. Opacity
4. Density

7-57. What part of the meniscus, if any, at the stem of the hydrometer indicates the ratio of the density of a solution to the density of distilled water?

1. The top
2. The center
3. The bottom
4. None

7-58. Acidity and alkalinity of solutions are measured with what instrument?

1. Hydrometer
2. pH meter
3. Activity indicator
4. Sensitometer

7-59. Photographic developing solutions have which of the following pH values?

1. 3.1 to 5.0
2. 5.0 to 8.0
3. 8.0 to 12.0
4. 12.0 to 14.0

7-60. An alkali may have which of the following pH values?

1. 1.0
2. 5.0
3. 7.0
4. 9.0

7-61. A pH value of 7.0 is

1. acidic
2. alkaline
3. neutral

7-62. A pH value of 1.0 is how many times stronger than a pH value of 3.0?

1. One
2. Two
3. Ten
4. One hundred

7-63. The solution used to standardize a pH meter is known as what type of solution?

1. Acid
2. Alkali
3. Buffer
4. Neutral

7-64. You are standardizing a pH meter before taking the pH reading of a black-and-white fixer. You should use a buffer solution with what pH value to standardize the meter?

1. 14.0
2. 10.0
3. 7.0
4. 4.0

Learning Objective: Identify procedures used in mixing photographic chemicals.

7-65. You have set up an impeller type of mixer to mix a developer solution, but you have adjusted the clamp improperly so the shaft is vertical and in the center of the container. What is the most probable end result?

1. The motor bearings are damaged
2. Too much air was whipped into the solution
3. The mixer vibrated enough to mix the chemicals sufficiently
4. The solution was churned from top to bottom, rather than from bottom to top

7-66. How many degrees Celsius equate to 68°F?

1. 10°C
2. 20°C
3. 30°C
4. 40°C

7-67. You are mixing a developing solution and the directions call for water at 23.8°C. This is equal to how many degrees Fahrenheit?

1. 18.75°F
2. 37.50°F
3. 75.00°F
4. 125.50°F

7-68. You are preparing a working solution of developer from a stock solution. The instructions call for 1 part of stock solution and 3 parts water. You need a total of 1 gallon of working solution. What amount of water, in ounces, should you add to the solution?

1. 32
2. 64
3. 96
4. 128

7-69. For adequate ventilation in a chemical mixing area, there should be one complete air change every

1. 15 minutes
2. 30 minutes
3. 3 minutes
4. 45 minutes

7-70. It is permissible to mix photographic chemicals in a photographic print room that has adequate ventilation.

1. True
2. False

7-71. You need 32 ounces of developer solution. The only size package of dry, prepackaged chemicals you have on hand makes 128 ounces. Should you mix the entire package to make 128 ounces and, if so, why?

1. Yes; when only part of the package is mixed, some of the ingredients may be left out of the resulting solution
2. Yes; when only part of the package is mixed, the resulting solution will not develop film
3. No; dry, packaged chemicals are homogenized
4. No; dry, packaged chemicals are formulated to be mixed either in part or in whole

7-72. You should follow what procedure when mixing chemicals?

1. Add water to dry chemicals and acid to water
2. Add dry chemicals to water and acid to water
3. Add water to dry chemicals and water to acid
4. Add dry chemicals to water and water to acid

Learning Objective: Recognize safety precautions required in chemical mixing areas.

7-73. Labels on chemical storage tanks must include the name of the solution, hazardous chemicals contained, the name of the person who mixed it, and what other information?

1. The water-mixing temperature
2. The date mixed
3. The antidote
4. The name of the chemical-mixing supervisor

7-74. What rule(s) is/are important to remember whenever you are working around chemicals?

1. An antidote is for emergency use only
2. Ingestion of a poisonous chemical may be induced by smoking
3. A person who has spilled acid on himself should seek medical attention immediately
4. All of the above

7-75. Which of the following personnel must be completely familiar with Material Safety Data Sheets (MSDS)?

1. The division officer only
2. The division officer and LCPO only
3. The division officer, LCPO, and production PO only
4. All persons within an imaging facility

ASSIGNMENT 8

Textbook Assignment: "Image Processing and Control." Pages 10-1 through 10-30.

Learning Objective: Recognize functions of the various solutions used to process light-sensitive materials.

8-1. What process is most commonly used for film development?

1. Physical
2. Chemical
3. Intensification
4. Latent conversion

8-2. When performed correctly, the chemical development process reduces exposed silver halides to what composition?

1. Black metallic silver
2. Soluble-silver salt
3. Dye-image salt
4. Gray-tone dye

8-3. All silver halides, both exposed and unexposed, can be reduced to metallic silver in the development process.

1. True
2. False

8-4. What term describes the amount of silver in a film emulsion that has been reduced to black metallic silver?

1. Light struck
2. Rate phenomenon
3. Density
4. Primary silver

8-5. What is the most important ingredient in a developing solution?

1. Preservative
2. Accelerator
3. Restrainer
4. Reducing agent

8-6. What is the purpose of the preservative in a developing solution?

1. It makes the image permanent
2. It retards oxidation
3. It prevents the formation of poisonous gas
4. It prevents the reducing agent from attacking the unexposed silver halides

8-7. Which of the following chemicals may be used as a preservative?

1. Hydroquinone
2. Metol
3. Sodium hydroxide
4. Sodium sulfite

8-8. What ingredient in a developing solution makes it alkaline?

1. Reducing agent
2. Accelerator
3. Preservative
4. Restrainer

8-9. What two functions does the accelerator in a developing agent serve?

1. It constricts the emulsion and prevents aerial oxidation
2. It constricts the emulsion and increases the rate of development
3. It swells the emulsion and absorbs the halide elements freed from the silver
4. It swells the emulsion and retards the rate of development

8-10. A developer with which of the following pH values will most likely produce an image with a finer grain?

1. 1.5
2. 5.5
3. 8.5
4. 11.0

8-11. The restrainer in a developing solution serves what purpose?

1. It slows down the action of the reducing agent
2. It prevents the preservative from etching the silver grains
3. It reduces image contrast
4. It prevents the solution from oxidizing

8-12. Which of the following developer ingredients is used to prevent chemical fog?

1. Metol
2. Hydroquinone
3. Sodium sulfite
4. Potassium bromide

Learning Objective: Identify different types of black-and-white developers and their uses.

8-13. In the development stage of film processing, what areas of the negative are converted to black metallic silver first?

1. Highlights
2. Mid-tones
3. Shadows

8-14. Which of the following factors does NOT determine the type of developer you choose to process film?

1. Film size
2. Type of process
3. Exposure conditions
4. Type of film

8-15. When black-and-white film is processed in a fine-grain developer, the grain structure cannot be seen even in prints made at high magnifications.

1. True
2. False

8-16. What type of developer should you use to process a line copy film?

1. High definition
2. Fine grain
3. High contrast
4. General purpose

8-17. Which of the following statements is NOT a property of a compensating developer?

1. It increases image sharpness
2. It may produce acceptable negatives that are one or two f/stops underexposed
3. It is recommended for use with fine-grain emulsions only
4. It produces extremely fine grain

8-18. What effect, if any, does the by-products caused by the reduction of silver halides have on the pH of a developing solution?

1. It increases
2. It decreases
3. None

8-19. Which of the following actions should you take to compensate for the additional bromide present in a used developer?

1. Increase the developing time
2. Decrease the developing time
3. Add more restrainer
4. Lower the temperature of the developer

8-20. Which of the following ingredients is NOT included in a developer replenisher?

1. Reducing agent
2. Preservative
3. Restrainer
4. Water

8-21. What is the primary reason for using a developer replenisher?

1. To allow use of the same developing solution indefinitely
2. To maintain the composition of a developer
3. To extract the used developer
4. To keep the developer activity constant

8-22. What replenishment method is used to maintain solution volume only?

1. Bleed
2. Topping off
3. Titration

8-23. The processing characteristics of a developer remains more consistent when what replenishment method is used?

1. Bleed
2. Topping off
3. Titration

Learning Objective: Identify procedures carried out after film is developed.

8-24. A water-rinse bath stops the action of the developer.

1. True
2. False

8-25. What property of a stop bath prevents further development?

1. Temperature
2. Volume
3. Penetrating action
4. pH

8-26. A solution with which of the following pH readings should be used as a stop bath?

1. 2.0
2. 5.0
3. 7.0
4. 9.0

8-27. A stop bath should be made up of a weak acid for which of the following reasons?

1. To prevent damage to the film emulsion
2. To prevent the fixing bath from sulphurizing
3. Both 1 and 2 above
4. To prevent darkroom workers from inhaling strong acid fumes

8-28. What type of acid is commonly used as a stop bath and in what strength (percentage)?

1. Sulfuric; 28.0%
2. Acetic; 99.5%
3. Sulfuric; 99.5%
4. Acetic; 28.0%

8-29. Glacial acetic acid freezes at what temperature, in degrees Fahrenheit?

1. 61°F
2. 32°F
3. 10°F
4. 0°F

8-30. For a normal stop bath, you should mix a total of how many ounces of 28 percent acetic acid with 32 ounces of water?

1. 1
2. 1/2
3. 16
4. 28

8-31. Once film is treated in a stop bath, it is no longer sensitive to light?

1. True
2. False

8-32. What step in film processing makes the silver salts that are not affected by the developer water soluble?

1. Water rinse
2. Stop bath
3. Fixer
4. Wash

8-33. Which of the following chemicals is used commonly as a silver-halide solvent?

1. Acetic acid
2. Sodium thiosulfate
3. Sodium sulfite
4. Borax

8-34. Which of the following chemicals is added to fixing solutions to prevent sulfurization and discoloration as well as aiding in prevention of stains?

1. Sodium thiosulfate
2. Ammonium thiosulfate
3. Sodium sulfite
4. Potassium alum

8-35. Which of the following films requires the longest fixing time?

1. Very fine grain
2. Fine grain
3. Medium grain
4. Coarse grain

8-36. You used an undeveloped piece of film to determine the proper fixing time. The film took 2 minutes to clear. After development, what length of time, in minutes, should you fix the same type of film?

1. 1
2. 2
3. 8
4. 4

8-37. A fresh fixer used to process black-and-white film takes 4 minutes to cleat- a piece of undeveloped film. The fixer should be considered exhausted when it takes a total of how many minutes to clear undeveloped film?

1. 5
2. 6
3. 7
4. 8

8-38. The purpose of washing film is to remove which of the following elements?

1. Black metallic silver
2. Fixer
3. Developer
4. Silver halides

8-39. For black-and-white film, the maximum recommended wash water is what temperature, in degrees Fahrenheit?

1. 65°F
2. 70°F
3. 75°F
4. 80°F

8-40. The time required to wash negatives in a large tank is 20 minutes. However, halfway through the wash cycle a PH Striker from the deck department puts his fixer-covered hand into the wash tank. You should wash the negatives what additional amount of time?

1. 5 minutes
2. 10 minutes
3. 20 minutes
4. 30 minutes

8-41. The final stage in film processing is what step?

1. Drying
2. Washing
3. Fixing
4. Captioning

8-42. Which of the following statements is correct regarding the wetting agent used in film processing?

1. It promotes even drying
2. It helps wash the film because it is made of a soaplike substance
3. It retards vigorous drying that causes film curl
4. It shrinks the swollen gelatin

8-43. You place a long roll of 35mm film in a film dryer to dry. What action should you take to prevent the film from curling?

1. Attach a film clip to the bottom of the roll
2. Cut the film into six-frame segments
3. Dry the film on the film reel
4. Hang the film in a U-shape loop

8-44. What is the best "cure" for film-drying problems?

1. Rewashing
2. Retouching
3. Prevention
4. Using a wetting agent

8-45. Film that is overdried can be identified by what characteristic?

1. The film curls toward the emulsion
2. The film curls toward the base
3. The base of the film turns pink
4. The images on the film appear faded

8-46. Film dryers use air impingement for what reason?

1. To help harden the gelatin
2. To cause the metallic silver to “set”
3. To prevent film curl
4. To promote faster drying

Learning Objective: Recognize equipment used in film processing.

8-47. Duckboards used in photographic processing sinks serve what purpose?

1. They rock trays and tanks to provide even agitation
2. They allow water to drain completely
3. They allow tanks or trays to float in the water bath
4. They allow water to circulate under and around tanks and trays to maintain chemical temperatures

8-48. What factor has the greatest bearing on selecting a safelight filter to use with a given photographic material?

1. The wattage of the light bulb
2. The working distance from the safelight to the light-sensitive material
3. The color sensitivity of the light-sensitive material
4. The length of time the light-sensitive material must be exposed to the safelight illumination

8-49. It takes 6 minutes to process a given light-sensitive material. To carry out the entire process of this material under the illumination of a safelight, you must ensure the safelight does NOT cause any evidence of fogging for what minimum length of time, in minutes?

1. 6
2. 8
3. 12
4. 24

8-50. What type of roll film reel is used most commonly in Navy imaging facilities?

1. Thumb-feed plastic
2. Center-feed plastic
3. Thumb-feed stainless steel
4. Center-feed stainless steel

8-51. A total of how many sheets of film can be washed properly at one time in a tray?

1. One
2. Two
3. Three
4. Four

8-52. What is the most effective method of washing film or paper in a tray?

1. Allow the water to fall directly on the film
2. Dump or change the water in the tray every 5 minutes
3. Rock the tray constantly
4. USC a siphon system

8-53. On board ships, a backflow preventer must be installed in the plumbing system when potable water is used to wash negatives and prints with a siphon system.

1. True
2. False

Learning Objective: Recognize procedures used in processing photographic film.

LIGHTING CONDITION
1. Dark
2. White light

Figure 8A

IN ANSWERING QUESTIONS 8-54 THROUGH 8-58, REFER TO FIGURE 8A. SELECT THE LIGHTING CONDITION USED TO CARRY OUT THE PROCESSING STEP USED AS THE QUESTION.

8-54. Fixing:

1. 1
2. 2

8-55. Drying:

1. 1
2. 2

8-56. Washing:

1. 1
2. 2

8-57. Developing:

1. 1
2. 2

8-58. Stop bath:

1. 1
2. 2

8-59. Which of the following factors affect film development?

1. Time
2. Temperature
3. Agitation
4. Each of the above

8-60. Which of the following publications provides complete processing information for all light-sensitive materials used in your imaging facility?

1. *Navy Visual Information Management and Operations Manual*
2. *Manual of Photography*
3. *Photo-Lab-Index*
4. *Kodak Guide to Film Processing*

8-61. For hand processing black-and-white film, you should agitate the film in what manner when (a) tray processing and (b) tank processing.

1. (a) constantly
   (b) constantly
2. (a) constantly
   (b) intermittently
3. (a) intermittently
   (b) intermittently
4. (a) intermittently
   (b) constantly

8-62. You are hand processing four rolls of 35mm film in a small tank designed to hold five 35mm reels. What action should you take before processing the film?

1. Place an empty 35mm reel in the bottom of the tank before placing the loaded reels
2. Place an empty 35mm reel on top of the loaded reels in the processing tank
3. Place an empty 35mm reel in the center of the processing tank in between the second and the third loaded reels
4. Process the film leaving empty space in the processing tank

8-63. When processing roll film in the tank-and-reel system, you should dislodge air bubbles from roll film in what manner?

1. Roll the tank along the bottom of the sink
2. Invert the tank several times
3. Shake the tank
4. Bang the tank on the edge of a hard surface

8-64. Which of the following processes is used to process color and some monochrome negative film in Navy imaging facilities?

1. Kodak E-6
2. Kodak Flexicolor
3. Kodak EP-2
4. Kodak RA-4

8-65. You are processing color negatives. During what processing step is temperature the most critical?

1. Color developer
2. Bleach
3. Fixer
4. Stabilizer

8-66. The Kodak E-6 process has what number of chemical steps?

1. Eight
2. Seven
3. Six
4. Four

8-67. You are processing color reversal film in the E-6 process. During what step is your first opportunity to subject the film to white light without fogging the film?

1. Final rinse
2. Fixer
3. Bleach
4. Reversal bath

8-68. You are hand processing a roll of Ektachrome film. The entire roll of film was underexposed by one f/stop. What alteration to the process should you make to compensate for the underexposure?

1. Increase the time in the first developer only
2. Increase the time in the first developer and the color developer only
3. Increase the time in the bleach by 2 minutes only
4. Increase the time of all processing steps by 20 percent

Learning Objective: Identify advantages and disadvantages of machine processing.

8-69. Which of the following advantages apply to photographic machine processors?

1. They can process a high volume of production efficiently
2. They provide more consistent results than hand processing
3. Both 1 and 2 above
4. They require very little maintenance

8-70. Which of the following factors is an advantage of the Image Maker processor?

1. It requires no maintenance
2. Operator error is impossible
3. It is capable of processing a number of different films and papers
4. The chemicals can be easily replenished and used indefinitely

8-71. What factor(s) determine(s) the processing time required on a roller--transport processor?

1. The depth of the processing tanks
2. The distance the film must travel
3. The machine speed
4. All of the above

8-72. You should consult which of the following publications for specifications on installing an automatic film processor?

1. The U.S. Navy Standard Installation Manual
2. The Kodak Processing Standards Manual
3. The manufacturer's installation and service manual
4. The Photo-Lab-Index

8-73. What unit of measure is used to express film processing time in an automatic roller-transport processing machine?

1. Feet per minute
2. Time in/out
3. Rate of travel
4. Roller rack rotation

8-74. The roller assembly in the fixing tank of a roller-transport processor holds 18 feet of film. The machine is operated at 7.5 feet per minute. What is the fixing time, in minutes?

1. 1.8
2. 2.4
3. 3.2
4. 4.1

8-75. The film exiting the dryer of an automatic processor is curled excessively. What action should you take?

1. Increase the transport speed
2. Decrease the transport speed
3. Increase the dryer temperature
4. Decrease the dryer temperature

ASSIGNMENT 9

Textbook Assignment: "Image Processing and Control," "Black--and-White Printing," and "Color Printing." Pages 10-31 through 12-17.

Learning Objective: Identify characteristics of high-quality negatives.

9-1. A black-and--white negative should make a good print when printed with what contrast printing filter?

1. No. 1
2. No. 2
3. No. 0
4. No. 4

9-2. What areas have the most density on a negative?

1. Highlights
2. Shadows
3. Midtones

9-3. The difference between the highlight and shadow densities describes what characteristic of a negative?

1. Opacity
2. Tonal gradation
3. Density
4. Contrast

9-4. Which of the following combined factors will produce a thin negative?

1. Underexposure and underdevelopment
2. Underexposure and overdevelopment
3. Overexposure and underdevelopment
4. Overexposure and overdevelopment

9-5. Which of the following areas in a photographed scene will produce the most density on a negative?

1. A shadow
2. A red car
3. A black sailor in winter blues
4. A white road sign

9-6. A processed black-and-white negative has good shadow detail but lacks good contrast and highlight densities. What is the most probable cause of these negative characteristics?

1. Normal exposure and overdevelopment
2. Normal exposure and underdevelopment
3. Underexposure and underdevelopment
4. Underexposure and normal development

9-7. Which of the following factors contribute to the graininess of a negative?

1. The type of emulsion
2. Development
3. Exposure
4. Each of the above

Learning Objective: Recognize equipment and the method used to monitor photographic processes.

9-8. What instrument provides consistent, repeatable exposures and is used to produce test strips?

1. Densitometer
2. Sensitometer
3. Photo sensitizer
4. Grier film exposer

9-9. A step tablet provides a range of what number of f/stops?

1. 21
2. 11
3. 10
4. 7

9-10. On a 21-step tablet, the difference in density between each step is what number of f/stops?

1. One
2. Two
3. One half
4. One third

9-11. What instrument is used to read densities from photographic papers and film?

1. Sensitometer
2. Densitometer
3. Emulsion meter
4. pH meter

9-12. You are reading the densities of a Kodacolor test strip. The filter setting should be set to what status?

1. M
2. K
3. C
4. A

9-13. When reading a control strip on a densitometer, you should take the readings from (a) what area of the step with (b) the emulsion facing in what direction?

1. (a) Center (b) down
2. (a) Center (b) up
4. (a) Edge (b) down
4. (a) Edge (b) up

9-14. On a process control chart, what does the symbol $\overline{X}$ represent?

1. The center line
2. The mean
3. The average
4. Each of the above

9-15. You plotted a Kodacolor control strip at the beginning of the production day. The HD reading plotted 0.10 units above the UCL. What action should you take?

1. Process the film normally
2. Speed up the processor by 10 percent
3. Add 1000 ml of developer replenisher
4. Notify your supervisor

Learning Objective: Recognize factors affecting the production and quality of contact black-and-white prints.

9-16. The most familiar type of photographic print has what type of base?

1. Paper
2. Film
3. Resin
4. Ester

9-17. What are the two primary methods of making photographic prints?

1. Positive and negative reproduction
2. Contact and projection printing
3. Precision and fallacious reduction
4. Enlargement and reduction printing

9-18. What printing method(s) can be used to produce print images that are the same size as the negative images?

1. Contact
2. Projection
3. Both 1 and 2 above
4. Precision

9-19. Variable-contrast photographic papers are not sensitive to which of the following colors of light?

1. Blue
2. Green
3. Red
4. Cyan

9-20. When hand processing black-and-white prints, you should use what minimum number of trays?

1. One
2. Two
3. Three
4. Four

9-21. What number of trays is recommended for hand processing black-and-white prints?

1. Five
2. Seven
3. Three
4. Four

9-22. Contact printing produces what negative to print ratio?

1. 1:1
2. 2:1
3. 1:2
4. 2:2

9-23. What grade of glass should be used when making color contact prints?

1. White
2. Neutral
3. Crystal
4. Clear A1

9-24. When using a proof printer, you should place the emulsion side of (a) paper and (b) film in what direction?

1. (a) Down (b) down
2. (a) Down (b) up
3. (a) Up (b) up
4. (a) Up (b) down

9-25. What is the main purpose of a masking device in a contact printer?

1. It protects the glass from scratches
2. It allows the prints to be produced with white borders
3. It holds the paper in place
4. It separates the negative from the glass

9-26. When viewed under a light source, the emulsion side of (a) film and (b) paper have what appearance?

1. (a) Shiny (b) shiny
2. (a) Shiny (b) dull
3. (a) Dull (b) dull
4. (a) Dull (b) shiny

9-27. What affect occurs when the material used to mask a contact print is too thick?

1. The print requires an excessive amount of exposure
2. The print image is reversed
3. The image is blurred along the edges
4. The paper does not get exposed

9-28. What term describes the guide on a contact printer that aides quick and proper paper alignment?

1. Mask
2. Goldenrod
3. Paper stop
4. Print border mark

Learning Objective: Identify steps used to process black-and-white paper and control the contrast of black-and-white prints.

9-29. When hand processing black-and-white prints, the image on the paper should appear in what length of time, in seconds?

1. 30
2. 15
3. 10
4. 5

9-30. You made a contact print with a number 3 contrast printing filter, but the print lacks adequate contrast. Which of the following filters should you use to make the reprint?

1. No. 1
2. No. 2
3. No. 1 1/2
4. No. 4

9-31. In hand processing, the term "pull" refers to what action?

1. Pulling the print through the entire process
2. Removing the print from the developer prematurely
3. Pouring chemical solutions
4. Removing prints from the dryer

9-32. A negative with normal contrast was printed with a No. 4 printing filter. Which of the following statements best describes the appearance of the prints?

1. The number of tones, reproduced matches the original scene tones closely
2. The print shows an abundance of middle tones with few shadow areas
3. The print is very flat
4. The print has high contrast

9-33. When developing prints in a tray, you should ensure they are agitated in what manner?

1. Frequently
2. Intermittently
3. Constantly
4. Infrequently

9-34. Which of the following statements is most accurate regarding print quality?

1. Print quality depends upon correct exposure only
2. Print quality depends upon correct development only
3. Print quality depends upon correct exposure and development
4. Print quality is governed by the working characteristics of the paper and developer

9-35. You are hand processing a single black-and-white print. The print should be treated in the stop bath for what number of seconds?

1. 20
2. 15
3. 10
4. 5

9-36. What is the most probable result of a fixing bath that is diluted less than recommended?

1. The prints sink
2. The prints float
3. The prints blister
4. The prints separate from the base

9-37. When hand processing photographic film and paper, it is common practice to work in what direction?

1. From right to left
2. From left to right
3. From top to bottom
4. From bottom to top

9-38. You are hand processing 26 8x10-inch prints at one time in a tray. You should agitate the prints in what manner?

1. Move the bottom print to the top of the stack
2. Move the top print to the bottom of the stack
3. Turn all the prints at one time and fan them quickly
4. Remove each print in succession from the developer, drain it for 5 seconds, then place the print at the bottom of the stack

9-39. You are processing several black-and-white prints at one time. You should treat the prints in the stop bath for what number of seconds?

1. 15
2. 30
3. 60
4. 90

9-40. After you remove a series of black-and-white prints from the dryer, you notice several of the prints have white fingerprints on them. What is the most probable cause of these fingerprints?

1. Fingerprints on the negative
2. Hands with developer on them touched the paper emulsion before processing
3. Hands with fixer on them touched the paper emulsion before processing
4. Dryer temperature was set too high and pressure from fingers made an indentation in the softened emulsion

9-41. To economize on the quantity of developer, you should use only enough solution to barely cover the paper.

1. True
2. False

Learning Objective: Identify methods used in projection printing.

9-42. “Dodging” and “burning in" are terms that best describe what type of control?

1. Contrast
2. Process
3. Exposure
4. Sensitivity

9-43. What method of printing allows you to correct for distortion?

1. Contact
2. Projection

9-44. A 4x5-inch negative is enlarged so the entire negative image is reproduced on an 8x10-inch print. What is the image magnification of this print?

1. 1x
2. 2x
3. 3x
4. 4x

9-45. All other factors being equal, what type of enlarger produces the greatest print contrast?

1. Condenser
2. Diffusion
3. Condenser-diffusion

9-46. What type of enlarger should you use to obscure negative defects?

1. Condenser
2. Diffusion
3. Condenser-diffusion

9-47. What type of black-and-white enlarger is used most commonly for general printing in Navy imaging facilities?

1. Condenser
2. Diffusion
3. Condenser-diffusion

9-48. Any high-quality camera lens can be used on an enlarger to produce high-quality prints.

1. True
2. False

9-49. You are printing a 4x5-inch negative. Which of the following focal-length enlarger lenses should you use?

1. 50mm
2. 75mm
3. 105mm
4. 150mm

9-50. With a lens-to-paper distance of 24 inches and all other factors being equal, which of the following focal-length lenses provides the greatest image magnification?

1. 50mm
2. 75mm
3. 105mm
4. 150mm

9-51. When photographic enlargements are being made, the term "cropping" is used to describe what procedure?

1. Setting the timer
2. Setting the aperture
3. Composing the image
4. Processing the prints

9-52. You made a test print without a contrast printing filter using an exposure of 10 seconds at f/11. The test print looks flat and you are going to make another test print using a No. 4 Ilford Multigrade printing filter. Keeping the timer on 10 seconds, you should make the new test print at what f/stop?

1. f/16
2. f/11
3. f/8
4. f/5.6

9-53. Which of the following printing techniques should you use to subdue facial blemishes;?

1. Dodging
2. Burning in
3. Diffusing
4. Vignetting

9-54. A negative you are printing has objectional grain structure. Which of the following techniques should you use to minimize this affect to the greatest extent?

1. Use a diffusion enlarger and glossy paper
2. Use a diffusion enlarger with matte-surfaced paper
3. Use a condenser enlarger and glossy paper
4. Use a condenser enlarger with matte-surfaced paper

9-55. In which of the following circumstances might you be concerned with depth of field when making enlargements?

1. When using dodging techniques
2. When using variable contrast papers
3. When printing a 35mm negative of a tall building
4. When the negative image shows shallow depth of field

Learning Objective: Recognize basic principles used in color printing.

9-56. What is the resulting color when blue is removed from white light?

1. Yellow
2. Green
3. Red
4. Magenta

9-57. What are the colors of the additive primaries?

1. White, gray, and black
2. Cyan, magenta, and yellow
3. Red, green, and yellow
4. Red, green, and blue

9-58. What are the colors of the additive secondaries and the subtractive primaries?

1. Red, green, and blue
2. Cyan, magenta, and yellow
3. Red, green, and yellow
4. White, gray, and black

9-59. The middle emulsion layer of color paper is sensitive to what color(s)?

1. Yellow
2. Red
3. Green
4. Each of the above



Figure 9A

IN ANSWERING QUESTIONS 9-60 THROUGH 9-62, REFER TO FIGURE 9A AND SELECT THE COLOR THAT RESULTS BY MIXING THE COLORS USED AS THE QUESTION.

9-60. Magenta and yellow:

1. 1
2. 2
3. 3
4. 4

9-61. Cyan and yellow:

1. 1
2. 2
3. 3
4. 4

9-62. Magenta and cyan:

1. 1
2. 2
3. 3
4. 4

9-63. What filter is used to remove ultraviolet radiation emitted by the light source of a color enlarger?

1. CC red
2. CP yellow
3. IR7
4. CP2B

9-64. A color enlarger lamp is designed to operate on 115 volts but is only receiving 95 volts. The color change of the output of the lamp is equivalent to what No. CC filter?

1. 05
2. 10
3. 15
4. 20

9-65. During exposure, the color paper received an excessive amount of green light. The processed print has what color cast?

1. Green
2. Magenta
3. Cyan
4. Yellow

9-66. When you are evaluating a color test print, the viewing light source should produce (a) what Kelvin temperature at (b) what number of footcandles of illuminance, and (c) what should the CRI be?

1. (a) 3950 (b) 55 (c) 90
2. (a) 4000 (b) 195 (c) 130
3. (a) 5000 (b) 100 (c) 95
4. (a) 5400 (b) 130 (c) 100

9-67. You are using color printing viewing filters to determine the color balance of a test print. On what areas of the print should you base your judgment?

1. Highlights
2. Shadows
3. Borders
4. Middle tones

9-68. The gray area in a color print has a red cast to it. Therefore, the light used to expose the print was deficient in what color?

1. Yellow
2. Red
3. Cyan
4. Blue

9-69. A color test print has a yellow color cast. Using a subtractive type of printer, you should make what modification to the filter pack?

1. Subtract yellow only
2. Add yellow only
3. Add blue only
4. Add magenta and cyan

9-70. Your calculated color printing filter pack is CC10Y + CC15M + CC05C. What should the actual filter pack be for the reprint?

1. CC15Y + CC25M only
2. CC15Y + CC25M + CC10C
3. CC05Y + CC15M only
4. CC05Y + CC15M +CC05C

9-71. A color test print has a blue color cast. Using an additive type of printer, you should make which of the following adjustments?

1. Add blue
2. Subtract blue
3. Add yellow
4. Either 2 or 3 above

9-72. What is the purpose of a standard negative?

1. It is used as a comparison of negative printing qualities
2. It serves as a tool to compare the printing characteristics of different emulsions
3. It can be used to program color analyzers and automated printers
4. Each of the above

9-73. You took portraits of four sailors. Each sailor had distinctly different skin tones; however, after the negatives were printed, all the skin tones were depicted alike. What is the most probable cause of error?

1. A skin tone was used for negative evaluation
2. The studio lights were the wrong Kelvin temperature
3. The same portrait lights were used to photograph all four sailors
4. The characteristics of the negative-positive system are such that all skin tones are reproduced alike

9-74. You are processing color prints using the RA-4 process. What is the approximate total processing time in minutes?

1. 2 3/4
2. 4 1/2
3. 8 1/4
4. 12

9-75. Which of the following characteristics apply to a minilab system?

1. It requires maintenance
2. It is capable of producing a high volume of prints
3. It is operated under normal lighting conditions
4. Each of the above

ASSIGNMENT 10

Textbook Assignment: "Motion Media," and "Job Control and Photographic Finishing." Pages 13-1 through 14-13.

Learning Objective: Identify basic principles of motion-picture photography.

10-1. What is the normal frames-per-second rate for motion pictures?

1. 12
2. 24
3. 48
4. 96

10-2. What characteristic of human vision contributes to the illusion of motion in motion-picture photography?

1. Persistence of vision
2. Image perception
3. Chromatic stimulation
4. Visual frequency response

10-3. With normal persistence of vision, the "after image" lasts approximately what length of time?

1. 1/2
2. 1/4
3. 1/10
4. 1/50

10-4. Each picture area on a strip of motion-picture film is referred to by what term?

1. Cut
2. Shot
3. Frame
4. Clip

10-5. What is the standard projection speed for a motion-picture film?

1. 8 fps
2. 16 fps
3. 24 fps
4. 36 fps

10-6. A motion-picture film shot at which of the following fps rates produces the illusion of slow motion?

1. 6 fps
2. 12 fps
3. 24 fps
4. 48 fps

10-7. What is the normal focal-length lens for a 16mm camera?

1. 50mm
2. 35mm
3. 25mm
4. 16mm

10-8. What is the result when a motion-picture camera is panned with a polarizing filter over the lens?

1. Variable darkening of the sky as the camera is panned
2. The polarizing grids cause the image to flicker
3. Excessive sky contrast results from the inability of the filter to rotate at the same rate as the camera is panned
4. Interference lines caused by the polarizing grids and the frame lines being out of synchronization

10-9. Which of the following is NOT an exposure controlling factor in motion-picture photography?

1. Film speed
2. Shutter speed
3. f/stop
4. Lens filter

10-10. A motion-picture camera operating at the standard speed with a shutter degree opening of 168 degrees has what approximate shutter speed?

1. 1/500 second
2. 1/250 second
3. 1/100 second
4. 1/50 second

Learning Objective: Recognize basic principles of motion video.

10-11. Motion video has which of the following advantages over motion-picture photography?

1. Film processing is not required
2. It is edited more quickly
3. Videotape is easily duplicated
4. Each of the above

10-12. In a color video camera, what device separates white light into the three primary colors?

1. The color separator
2. The beam splitter
3. The automatic gain control
4. The frequency generator

10-13. What is the aspect ratio of a motion-video frame?

1. 2:1
2. 2:3
3. 3:4
4. 3:5

10-14. What term describes unwanted sounds or electrical interference in an audio or video signal?

1. Dropout
2. Capstan
3. Dub
4. Noise

10-15. What term depicts the smallest single picture element from which an image is constructed?

1. Frame
2. Field
3. Pixel
4. Composite

10-16. In a composite video signal, what does "Y" represent?

1. Yellow
2. Luminance
3. Color
4. Sound

10-17. What is/are the main cause(s) of dropout?

1. Poor microphone connection
2. Dirty heads
3. Imperfections in the tape
4. Both 2 and 3 above

10-18. What component in a video camera serves the same purpose as film in a motion-picture camera?

1. The cathode-ray tube
2. The charged-coupled imaging device
3. The beam splitter
4. The character generator

10-19. One complete television image is composed of what number of fields?

1. One
2. Two
3. Three
4. Four

10-20. A complete charge-forming-and-scanning process within a motion-video camera occurs what number of times per second?

1. 10
2. 20
3. 30
4. 60

10-21. Information from what section of a videotape allows the tape to be played on different but similar types of video players?

1. Control track
2. Video monitor
3. Video synchronizer
4. Helical control

10-22. The Hi8 system is completely compatible with all other recording systems.

1. True
2. False

Learning Objective: Identify guidelines used when shooting motion-picture photography.

10-23. You recorded a scene on a camcorder and the image appears grainy and flat. This appearance probably occurred due to which of the following causes?

1. A high-speed videotape was used
2. The scene brightness level was too high
3. The scene brightness level was too low
4. The gain was accidently increased during recording

10-24. In which of the following situations should you manually focus a camcorder while recording a scene?

1. When the subject is extremely backlit
2. When the scene contains little contrast
3. When moving objects pass between the camera and the subject
4. Each of the above

10-25. Which of the following focal-length lenses should you use while shooting a motion-media scene from a moving boat?

1. 15mm
2. 25mm
3. 50mm
4. 75mm

10-26. What is the first rule of panning with a motion-media camera?

1. Pan from left to right
2. Pan only when using a fast shutter speed
3. Pan only when necessary
4. Pan with a short focal-length lens

10-27. Primary movement refers to the visual effect of motion that is created by what source?

1. Single camera
2. Multiple cameras
3. Computer graphics
4. The subject

10-28. What motion-media shot is used to tell where the action takes place?

1. ELS
2. LS
3. MS
4. CU

10-29. What motion-media shot is used to tell what action is taking place?

1. ELS
2. LS
3. MS
4. CU

10-30. What motion-media shot is used to present only action of primary interest?

1. ELS
2. LS
3. MS
4. CU

10-31. You made several shots of a subject using different camera angles. However, in one shot the background appears much different and looks as though it was shot in a different location. What rule of videography did you violate?

1. Action match
2. Shot variety
3. Continuity
4. Sequential shooting

10-32. The subject of a video is shown moving directly toward the viewer. What type of screen direction is portrayed?

1. Forward
2. Neutral
3. Head on
4. Nondirectional

10-33. What type of shot is made when the video camera is moved to follow a subject creating neutral screen direction?

1. Traveling abreast
2. Constant screen direction
3. Tracking
4. Direction of travel

10-34. You are videotaping a baseball game. During the game, you shot several scenes of a boy eating a hot dog. This is what type of shot?

1. Reestablishing
2. Establishing
3. Cutaway
4. Cut in

10-35. You are videotaping a soccer game. During the game, one of the players kicks the ball into the face of the referee. During halftime, you shoot a reenactment of the event. This is what type of shot?

1. Reestablishing
2. Establishing
3. Cutaway
4. Cut in

10-36. As a Navy Photographer's Mate, you can expect most of your motion-media work to be of the uncontrolled-action type.

1. True
2. False

10-37. What is the purpose of slating videotape?

1. To identify the film
2. To ensure the camera is operating at the proper speed
3. To take up slack in the cassette
4. To color balance the camera on a neutral-gray colored object

10-38. A slate should be recorded for what minimum number of seconds?

1. 30
2. 20
3. 3
4. 10

10-39. What form must accompany all media products forwarded to a Still and Motion-Media Records Center?

1. Video/film data sheet
2. Visual information caption sheet
3. Photographic job order
4. NAVAIR form 12700

10-40. Videotapes should be stored in what manner?

1. Upright only
2. Horizontally but not more than five high
3. Horizontally but not more than ten high
4. It makes no difference since videotapes are extremely durable

Learning Objective: Recognize security procedures used in Navy imaging facilities.

10-41. Security-related information pertaining to the Navy is contained in what instruction?

1. OPNAVINST 5290.1
2. OPNAVINST 5510.1
3. SECNAVINST 3150.6
4. SECNAVINST 5212.5

10-42. Only those Photographer's Mates with a security clearance are responsible for safeguarding classified material.

1. True
2. False

10-43. Security classifications are categorized in what number of designations?

1. One
2. Two
3. Three
4. Four

10-44. What is the highest security classification?

1. Cryptographic
2. Cosmic
3. Exclusion
4. Top Secret

10-45. At a Las Vegas hotel, you shot several rolls of film about sailors conducting themselves in actions that are unbecoming. These photographs could be detrimental to their careers and cause them much embarrassment. What classification, if any, should these photographs bear?

1. Secret
2. Confidential
3. For Official Use Only
4. None

10-46. A roll of film that contains images of classified information should be marked in what manner?

1. On the emulsion side beneath each frame
2. On the emulsion side at the beginning and end of the roll
3. On the base side beneath each frame
4. On the base side at the beginning and end of the roll

10-47. Classified 8x10-inch prints should be marked with the appropriate classification in what number of places?

1. One
2. Two
3. Three
4. Four

10-48. A classified videotape should be marked appropriately in what location(s)?

1. At the beginning of the videotape only
2. At the end of the videotape only
3. On the tape case only
4. At the beginning and end of the videotape as well as on the tape case

10-49. As a Photographer's Mate, you must protect classified material by what means?

1. Censorship and transmission
2. Cryptographic and transmission
3. Censorship and physical
4. Physical and cryptographic

10-50. A record of destruction of Top Secret material must be retained for what number of years?

1. 1
2. 2
3. 3
4. 4

10-51. What type of security area requires the strictest access control?

1. Restricted
2. Controlled
3. Limited
4. Exclusion

10-52. What person is directly responsible for safeguarding classified material in an imaging facility?

1. The division officer
2. The department head
3. The commanding officer
4. The security manager

10-53. Which of the following items should NOT be stored in a class A vault?

1. Top Secret
2. Secret
3. Confidential
4. Imprest funds

10-54. The combination to a safe used to store classified material must be changed at an interval not to exceed what period of time?

1. 1 year
2. 6 months
3. 3 months
4. 1 month

10-55. Which of the following combinations should NOT be used for a safe containing classified material?

1. 6-37-50
2. 5-10-15
3. 22-47-9
4. 2-53-12

10-56. When a safe is taken out of service, it should be reset to what combination?

1. 50-25-50
2. 25-50-25
3. 10-20-30
4. 5-10-15

Learning Objective: Recognize administrative procedures used in Navy imaging facilities.

10-57. Navy imaging administrative and operating procedures are contained in what instruction?

1. OPNAVINST 5290.1
2. NAVEDTRA 13014
3. SECNAVINST 3150.6
4. NAVAIRSYSCOMINST 10700.2

10-58. The job order number in the job order log should be reset annually to 000001 on what date?

1. 1 January
2. 1 April
3. 1 August
4. 1 October

10-59. The job order form serves what purpose?

1. As a customer receipt
2. As an authority to perform work
3. As a record of expenditures
4. Each of the above

10-60. A color negative is identified by what VIRIN code?

1. SCN
2. VPS
3. CLN
4. CLR

10-61. You are preparing the VIRIN for an unclassified, color slide that was shot on 10OCT93. Which of the following examples is appropriate for the slide?

1. N0341-SPT-93-000020
2. N0341-SPT-94-000020
3. N0341-SPT-93-000020-UC
4. N0341-SCS-94-000020

10-62. The VIRIN of a videotape cassette should be recorded at the beginning of the tape for a minimum of what viewing time, in seconds?

1. 5
2. 10
3. 15
4. 30

10-63. All Navy imaging products forwarded to a Visual Information Records Center for preaccessioning must be accompanied by what form?

1. DD Form 10700
2. DD Form 2537
3. DD Form 1348
4. OPNAV 5290/1

Learning Objective: Identify methods used to mount prints.

10-64. Normally, prints are mounted in which of the following ways?

1. With all borders equal
2. With the top border being the widest
3. With the bottom border being the widest
4. With a mounting board that has loud, contrasting color

10-65. Which of the following adhesives should you use to mount photographic prints on a mounting board?

1. Rubber cement
2. Gum arabic
3. Paste
4. Glue