TM 11-401-2

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

ARMY PICTORIAL TECHNIQUES, EQUIPMENTS AND SYSTEMS

STILL PHOTOGRAPHY

HEADQUARTERS, DEPARTMENT OF THE ARMY
SEPTEMBER 1969

TECHNICAL MANUAL
No. 11-401-2

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *16 September 1969*

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***This manual supersedes so much of TM 11-401, 10 December 1953, including C1, 28 June 1961, as pertains to still photography.**

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1–1. Purpose and Scope

a. This manual is a guide for training military personnel in the procedures and techniques of still photography. The manual covers the basic principles of still photography, including administrative controls, composition, and perspective. It also presents material on equipment and methods used for portrait, group, and copy photography as well as color, flash, infrared, polaroid, and other special types of still photography. Aerial photographs, planning aerial photo missions, and aerial camera systems and auxiliary equipment are also covered in the manual.

b. The material covered in this manual is applicable to both nuclear and nonnuclear warfare.

c. This is the second manual in a progressive series entitled Army Pictorial Techniques, Equipments, and Systems. The first in the series, TM 11–401–1, discusses the pictorial fundamentals and contains information prerequisite to understanding material in this second manual.

d. Users of this manual are encouraged to submit recommended changes or comments to improve the publication. Comments should be keyed to the specific page, paragraph, and line of the text in which a change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications) and forwarded direct to Commanding General, United States Army Signal Center and School, ATTN: AHDC–DLP–TLD, Fort Monmouth, N.J. 07703.

1–2. References, Glossary, and Index

Appendix A lists other publications that contain information relative to the material in this manual. Appendix B is a glossary of terms used in still photography. A subject index is included at the rear of the manual.

Section II. TYPES OF STILL PHOTOGRAPHY

1–3. General

a. For the military photographer, photography is an occupation that produces photographs to satisfy a specific assignment. So, to produce a useful picture, you, as the photographer, must be thoroughly familiar with your assignment and with the particular characteristics of the type of picture required. You must know the fundamental techniques, methods, and equipment to use in producing each of the many types of still photographs.

b. The following paragraphs summarize and describe the kinds of still photographs. All of these subjects will be discussed in detail in the subsequent chapters of this manual.

1–4. Portraits

Portraits of individuals (ch. 3) are used for records, identification, and display, so they must bear a good likeness of the person being photographed. Consequently, good lighting and posing techniques are particularly important in producing good portraits.

1–5. Group Photographs

Photographs of groups (ch. 4), formal or informal, are used for publicity and recruiting, in addition to records. The main consideration in photographing a group is to show everyone in the group in the proper perspective with a minimum of distortion. This is accomplished by properly positioning the camera and using the appropriate focal length lens.

1–6. Copy Photography

Basically, copy photography (ch. 5), involves photographing a flat original (map, document, picture, etc.) that may be just black on white or may be many colors or shades. The techniques you use will depend on the reason the copy is being made, the number of shades in the original, and any improvements you might want to make in the copy. Lighting the original uniformly is of particular importance so that the copy will be entirely clear and readable.

1-7. Special Types

Special types of still photographs—equipment, legal, panoramic, adverse light, and action—all require special planning peculiar to their use and qualities. *For example,* equipment photographs (ch. 6, sec. I) must be highly detailed and technically correct. Legal photographs (ch. 6, sec. II) are used in crime detection and for evidence, so they must clearly picture only the facts. Panoramic or extra wide views (ch. 6, sec. III) require a special camera or lens or special procedures with regular cameras. Under adverse lighting conditions (ch. 6, sec. IV) the photographer needs to employ good photographic practices to compensate for or correct the poor condition. Pictures of action or moving scenes (ch. 6, sec. V) also require special techniques to capture the subject clearly on film.

1-8. Infrared Photography

Infrared radiation is invisible to the human eye but not to the camera, which can record infrared on special, sensitive film. Infrared photographs (ch. 7) do not appear natural because objects do not reflect the same amount of infrared as visible light. Consequently, some things are invisible in infrared photographs, some show up more clearly, and some only vary in brightness from how they would appear on regular film. Infrared photography is especially useful in combat and reconnaissance to detect camouflage and to take night pictures without using visible flash lighting.

1-9. Flash Photography

Flashbulbs provide light not only indoors and at night but also in the daytime to add brilliance, lower contrast, and increase shadow detail in photographs. The light in the bulb is produced by a burning filler, usualy a metal such as magnesium. The peak brightness, total light, and timing differ from one type of bulb to another so you must adjust the camera shutter and lens to get just the right amount of light at the right time for the particular photograph. The advantages of electronic flash over flashbulbs are numerous. The outstanding quality of electronic flash is that the extremely short duration of the flash stops movement whether it is subject or camera movement. The result is sharper pictures (ch. 8).

1-10. Color Photography

Photographs in color (ch. 9) are more natural than in black and white because our eyes see in color. Color brings life, depth, and realness to a picture. The peculiar characteristics of color film require that you expose for highlights and light the shadow to obtain true color rendition with either daylight or artificial light.

1-11. Diffusion Transfer Photography

The diffusion transfer process (Polaroid is the commercial name) enables you to take a photograph and develop it within a minute so that you are immediately certain of the results (ch. 10). The process is simple, eliminates the need for laboratory equipment, and has many military uses.

1-12. Military News and Information Photography

The Army uses news photography for informing the military and public, for promoting interest in the Army, and for record purposes. Some of your main jobs as an Army photographer will be photographing VIP's and covering awards and presentation ceremonies. You will need tact, imagination, and, of course, technical competence to get the right kind of news photographs (ch. 11).

1-13. Aerial Photography

The Army finds aerial photography (chs. 12 through 18) particularly useful to learn about enemy defenses, concentration, and movements; to observe battle sites; and to study the effectiveness of our own defenses. Taking an aerial photograph requires careful planning of all aspects of the mission because often there is only one chance to make the photograph. You must, first of all, decide the type of aerial photograph that will give the best coverage of the target. Then you must choose the right type of camera system, film, and auxiliary equipment to use. And, along with the pilot, you prepare the flight plan.

CHAPTER 2

PHOTOGRAPHIC CONTROLS

Section I. CONTROLS

2-1. Your Pictures Have a Purpose

a. To you as a military photographer, photography is not a hobby; it's an occupation that produces a useful product—pictures that can be used for identification, reconnaissance, or public information. Each picture should possess artistic value and must serve a purpose. As the photographer, your job is to obtain pictures that fulfill the purpose of your assignment.

b. Useful pictures do not just happen; they require a great deal of effort and depend on many factors, namely—

(1) Your *knowledge* of the intent, purpose, and background of your assignment as well as your knowledge of photographic equipment.

(2) The *skill* with which you apply your knowledge of photographic principles and the skill with which you use your camera. Any device —camera, typewriter, computer—is only as good as the person who is operating it.

(3) The *controls* or rules, regulations, and principles that govern the quality of your pictures.

2-2. Operational Controls

Operational controls govern what you will photograph. These controls include AR 108-5, your assignment, plan of operation, personal conduct, and recordkeeping.

a. AR 108-5 establishes policies, defines responsibilities, and prescribes the photographic functions and administration of all Army agencies, activities, installations, and units engaged in pictorial operations. We will explain some parts of this regulation in the following paragraphs, but we will not restate it completely in this text.

b. Your assignment tells you what to photograph and why; it establishes the purpose for the pictures you take. You photograph to fulfill the intent and purpose of your assignmnet—heavy makeup and an expensive wardrobe may make a WAC photograph perfectly for a fashion magazine cover, but the same photograph is unsuitable for an ID card.

c. You must plan your mission before you undertake the assignment. If you have a good idea of what the finished prints will look like before you start the assignment, you will produce better pictures. This requires that you study the assignment before you take any photographs.

d. Your personal conduct reflects on your unit and the Army. You must do your job politely, diplomatically, and considerately.

e. Each exposure must be accompanied by a written record on DA Form 3315 (Photographer's Caption). The photograph shows only what the camera recorded; the writeup tells what may or may not be seen. Write the caption as soon as possible after you take the photograph; do not rely on your memory. The caption need not be a master composition, but it should contain at least the following information:

(1) An identification number.

(2) The date and time the photograph was made.

(3) The full title, name, and serial number of all people or items photographed.

(4) An accurate description of where the photograph was made.

(5) A brief description of what you intended to capture on film and all pertinent background information.

(6) Any other data that would aid in processing or using the print.

2-3. Technical Controls

Technical controls govern how you will photograph a subject to get the picture that will best serve the purpose of your assignment. These controls consist of composition, perspective, camera adjustments, filters, and film. We will discuss each control in detail in the following five sections of this chapter.

Section II. COMPOSITION

2-4. Composition is Arrangement

a. Composition is the arrangement of parts or objects in a picture. A good photographer does not just record whatever he sees; he puts together or composes the picture. To do this the photographer either waits until all objects are properly related, or he places the objects in their proper relationship.

b. Good composition serves a purpose, sets a mood, and tells a story. Your camera will record whatever it sees, exactly as it sees it, without any consideration or feeling of what is happening, or why. It is up to you to capture the location, excitement, and attitude of the event. If you properly place objects in the picture, you will give the photograph more meaning by clearly showing the situation and reflecting the feeling of the occasion.

2–5. Follow the Principles of Good Composition

a. In the following paragraphs in this section we'll discuss many principles of good composition. You'll find that they are general enough for you to put your own personality into the composition of the photograph. If you fail to follow the rules of good composition the viewer might not interpret your photograph correctly.

b. Just as we recommend that you follow these principles, we also recommend that you do not adhere *strictly* to them. The rules of good composition are general rules, and they can be bent to fit your situation. So bend them, but don't break them.

c. You'll find that the obverse of a rule is generally true and just as usable as the rule. Consider the rule, "an orderly arrangement evokes serenity," with its obverse, "a disorderly arrangement evokes unrest." The orderly arrangement in A of figure 2–1 shows that all is under control, while B of the same figure is littered with danger.

2–6. Simplicity is the Keynote

Simplicity of composition is the expression of *one* idea with enough detail to show the complete idea and the picturing of *one* principal subject. Each picture should express just one thought in order to hold the viewer's interest. Any attempt to present more than one idea in a picture is confusing and reduces the effectiveness of the presentation. A picture is usually viewed quickly; therefore, you must get the message across quickly. So keep it short and simple.

a. Simplicity in Subjects. A photograph may contain many people, but only one or two should stand out. If the purpose of the picture is to show a new piece of equipment, then that piece of equipment should command the viewer's attention. Other equipment, people, or large objects distract the viewer's attention.

b. Simplicity in Detail. A photograph with excessive detail looks unorganized, and one with no detail at all looks vacant or unfinished. The amount of detail you include in your photograph depends on the purpose of your assignment, but the total amount should be just sufficient to tell the complete story. If the purpose of your assignment is *to show the operating controls* of a piece of equipment, then all the controls and markings on the equipment should be clearly visible; there should be no background detail and no shadows. On the other hand, if the purpose of your assignment is *to show the operation* of a piece of equipment, then distinct markings may not be necessary. Show the equipment in its nor-

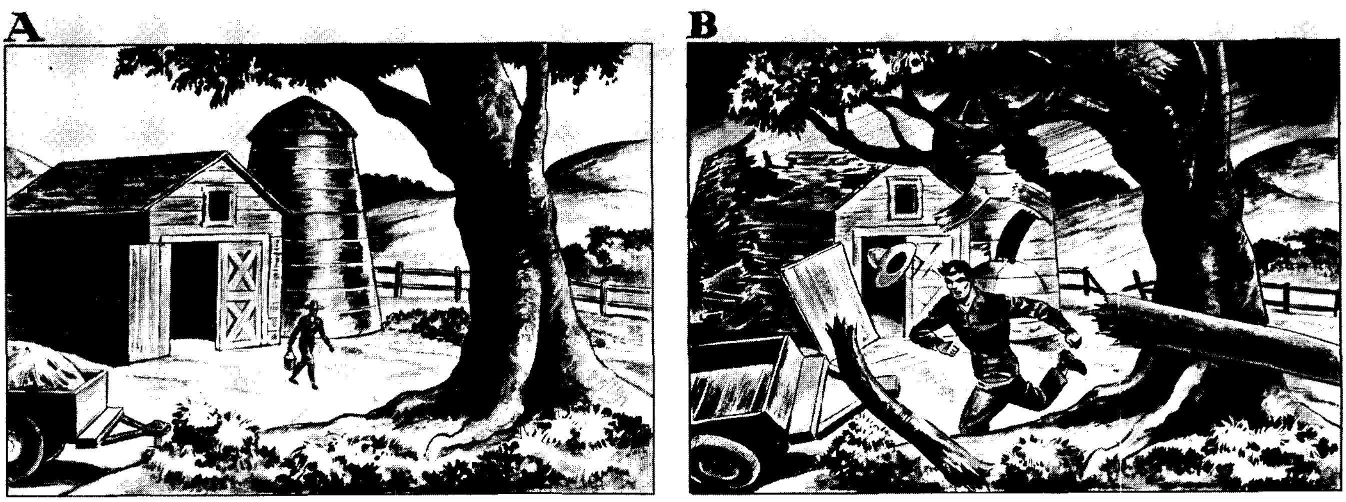

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Figure 2–1. Serenity and unrest.

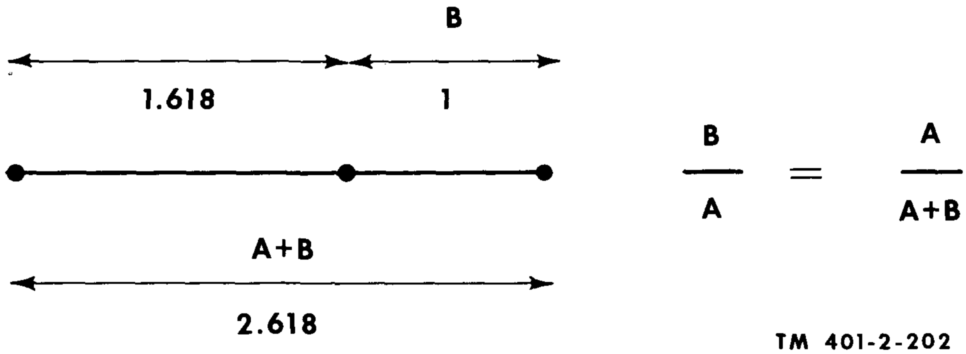


Figure 2–2. Ideal division of a line.

mal environment and include shadows for depth and realism.

2–7. Center of Interest

There should be one point in your picture that commands the major portion of the viewer's attention. This is called the *center of interest* and is where you place the principal subject or action. One carefully placed center of interest allows the viewer to absorb the picture quickly. Two equal centers of interest cause his gaze to leap back and forth from one to the other and do not give time for the thought of the picture to penetrate; three or more equal centers of interest cause utter confusion.

a. You should place the center of interest so that the viewer can see the complete picture easily. You determine the ideal placement for the center of interest from the rule for the ideal division of a line (fig. 2–2). The rule states that the ratio of the length of the smaller part of a line (B) to the larger part of that line (A) equals the ratio of the larger part (A) to the whole line (A+B). This rule is expressed mathematically as

$$\frac{B}{A}=\frac{A}{A+B}.$$

If we solve this mathematical equation we find that the ratio of A:A+B is 1:1.618 or approximately 2 to 3. We use this ratio of 2:3 to locate the ideal placement of the center of interest—⅔ the picture width from either side and ⅔ the picture height from the top or bottom. To easily locate the ideal site for a center of interest, *consider the scene as a ticktacktoe board and locate the center of interest at any one of the intersections of the lines* (fig. 2–3).

b. The center of the interest should not be dead center; dead center, especially a very strong center, has a hypnotic effect on the viewer. His eyes go to the center almost immediately and stay there. His gaze becomes a fixation, and he sees only that one point—the rest of the picture is lost. The effect of the picture might also be lost if the center of interest is near the edge of the photograph. Ths brings the viewer's gaze to the edge of the picture and might move his attention out of the picture completely.

2–8. Balance Your Picture

a. A single object placed at the center of interest creates an imbalance that could disturb the viewer. Although most people want some change

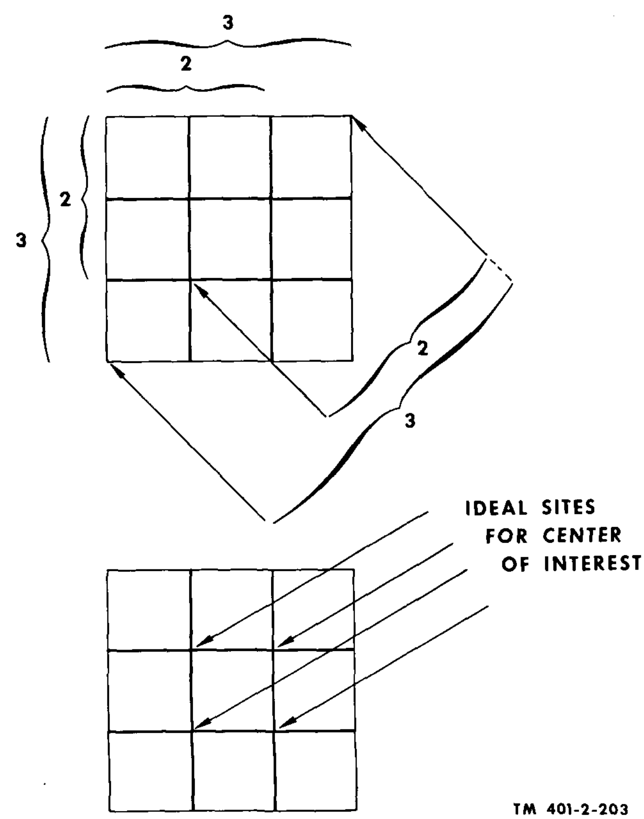


Figure 2–3. Location of center of interest.

and variety, they prefer a stable and balanced photograph. In certain circumstances an imbalance is desirable, but normally you should try to balance your picture.

b. To get balance in a picture you can use equal size objects symmetrically placed, a small object near the edge of the picture, or an apparently small object in the distance.

c. The perfect symmetry you get by balancing two equal objects is not the best method of obtaining balance because it tends to make the picture dull, mechanical, and lifeless. You can break up the symmetry and still retain the balance by placing each subject in a slightly different pose. *For example,* a closeup of two men standing shoulder-to-shoulder and facing the camera will produce a stiff photograph; but if one man faces the camera and the other turns slightly toward him, the picture will be more lifelike. Another example is shown in figure 2–4.

d. A large object near the center can balance a small object near the edge of the picture because balance is a combination of weight and distance. A small weight placed a long distance from the point of balance can balance a large weight. This is the principle used by the man in figure 2–4 who is using a lever to move a heavy weight.

e. You can also obtain the distance needed for balance if you place an object deep into the picture. The object in the distance need not be small, but its image on the photograph should be small. The large hill (small image) in the distance in figure 2–4 balances the man in the foreground. Note also that the center of interest (the man's eye) is located at one of the ideal sites for a center of interest and that the balancing object (the hill) is also located at an ideal site for a center of interest.

f. Don't try to balance extremely large areas that will split your picture into two equal halves. *For example,* the horizon should be one-third up from the bottom of the picture or one-third down from the top of the picture, but never in the middle of the picture. Either sky or earth should dominate, and the dominating feature should contain the center of interest (fig. 2–5).

2–9. Direction Lines Lead the Eye

a. When you look at a picture, its arrangement should lead your eyes to the center of interest. You should use lines to do this; lines that look like lines, lines that don't look like lines, outlines, and even invisible lines all can be used as direction lines to lead the viewer to the action at the center of interest.

b. The unseen line can effectively cause us to look in a given direction. *For example,* when we see a man staring into the sky, we look to see what he is staring at; when we see a pointed finger or rifle, we look for the target. Even bent trees or waving flags will cause us to look to see where the wind is going. Our eyes follow the line of another mans' gaze (the center man of figure 2–6), the line of movement, or the line of force.

c. Every object or group of objects forms lines and can be used as direction lines to direct the observer to the center of interest. The wire cables in figure 2–6 look like lines made with a pen to point out the center of interest. The men in the picture may not look like lines, but each is a short

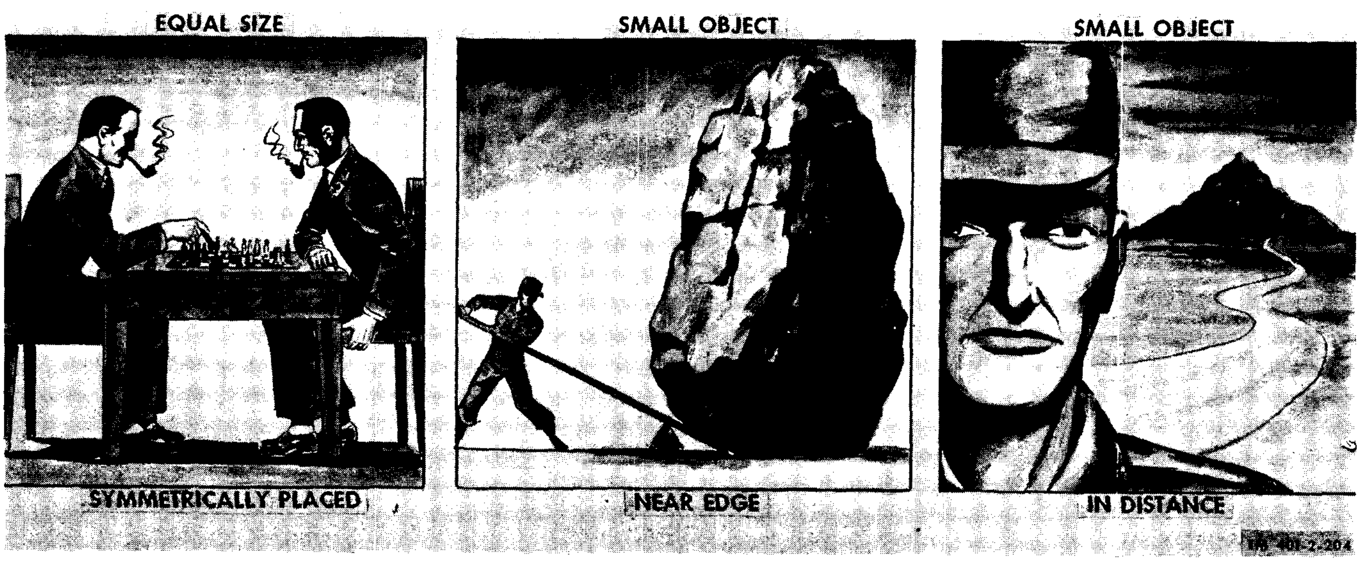


Figure 2–4. Balance.

Figure 2–5. Don't balance sky and earth.

vertical line and together they form a broken line that directs your gaze.

d. Groups of objects may produce direction lines. *For example*, consider a row of trees fading off into the distance. Each tree by itself is a vertical line, but as a group they lead the eye into the picture.

2–10. Lines Give Character

Lines have meaning (fig. 2–7) and promote certain characteristics.

a. Horizontal lines indicate peace and quiet. This is our position as we lie in restful sleep.

b. Vertical lines indicate strength and power. For instance, a man standing straight and tall is a picture of control and mastery.

c. Diagonal lines indicate force and action. To illustrate this, picture a man leaning into his work or putting his shoulder to the wheel.

d. Curved lines indicate grace and charm. *For example*, the arched body gives beauty to a perfectly executed back dive.

2–11. Tonal Separation Gives Depth and Life

If you're not colorblind, you see a scene in color. A camera with black and white film reproduces that same color scene in various shades of black, gray, and white. The object you see ordinarily because of its color may be invisible in a photograph if the camera reproduces an image of that object in the same shade of gray as the background. This, of course, in an extreme example. Occasionally an object is hidden in a photograph because of the similarity in the shades of gray, but rarely is it completely invisible.

a. This difference in shades of gray in a black and white photograph is called *tonal separation*. If there is no tonal separation, objects and areas blend together, and the result is a loss of detail and clarity. Also, the sameness of gray throughout the picture is dull and uninteresting. You can photograph with proper tonal separation if you select the correct film (sec. VI), the correct filter (sec. V), and if you use the proper exposure and have contrasting features and distinct shadows. We are concerned here with light and contrast and the way they affect tonal separation.

b. Contrasting features in a photograph stand out, but you must use moderation. High contrast on a photograph can be just as lacking in tonal separation as low contrast. In extremely high contrast, *all* the dark grays have the same tone —pitch black, and all the light grays have the same tone—pure white. Also, while it is true that contrasting colors normally contrast on black and white film, the amount of *light reflected* from an object has the greatest control over tonal separation, not the color of the object.

c. Since light is the big factor in determining tonal separation, you may have to use artificial light or reflectors even on a bright sunny day in order to bring out details hidden in the shade. *For example*, the shadow of a man's hat may hide his face in deep shade. But by placing just a little light on his face you can retain the shadow and still effect enough tonal separation to bring out his facial features. Again, use moderation because too much light can also result in poor photographs.

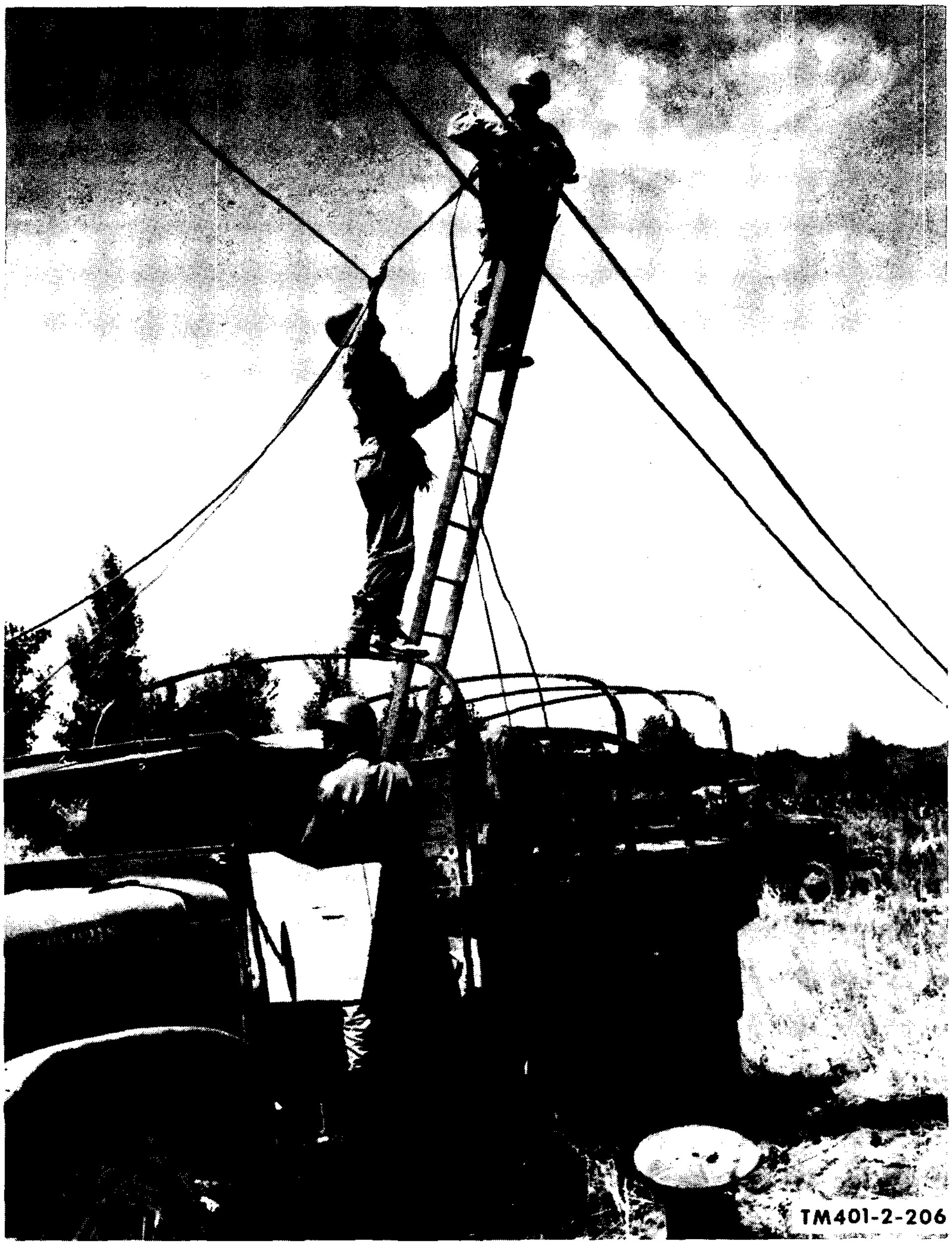


Figure 2–6. Direction lines.

d. Light, contrast, and shadows will all help sharpen your pictures, but for the most effective tonal separation you may have to use a filter. The exact type of filter you use depends on the effect you want (sec. V).

2–12. Depth Puts the Observer in The Picture

A photograph has a two-dimensional flat image of height and width. It's up to the photographer to compose a picture with the feeling of the third dimension—depth. Depth adds direction and atmosphere to a picture and makes the observer feel he is really at the site. Principally, depth is an illusion created by perspective (sec. III), but there are many techniques you can use to create an illusion of depth. *For example*—

a. Use a strong sidelight to create shade and shadow. These two forms will give an object body and depth.

b. Separate the subject from the background to make the subject look as if its in front of the background. There are two ways you can do this: first, light the subject from the rear, and second, put the background out of focus.

c. The position of an object suggests depth. If you want an object to appear far away, place it high in the picture or close to the horizon.

d. Use a winding road, a fence, a sign, a row of

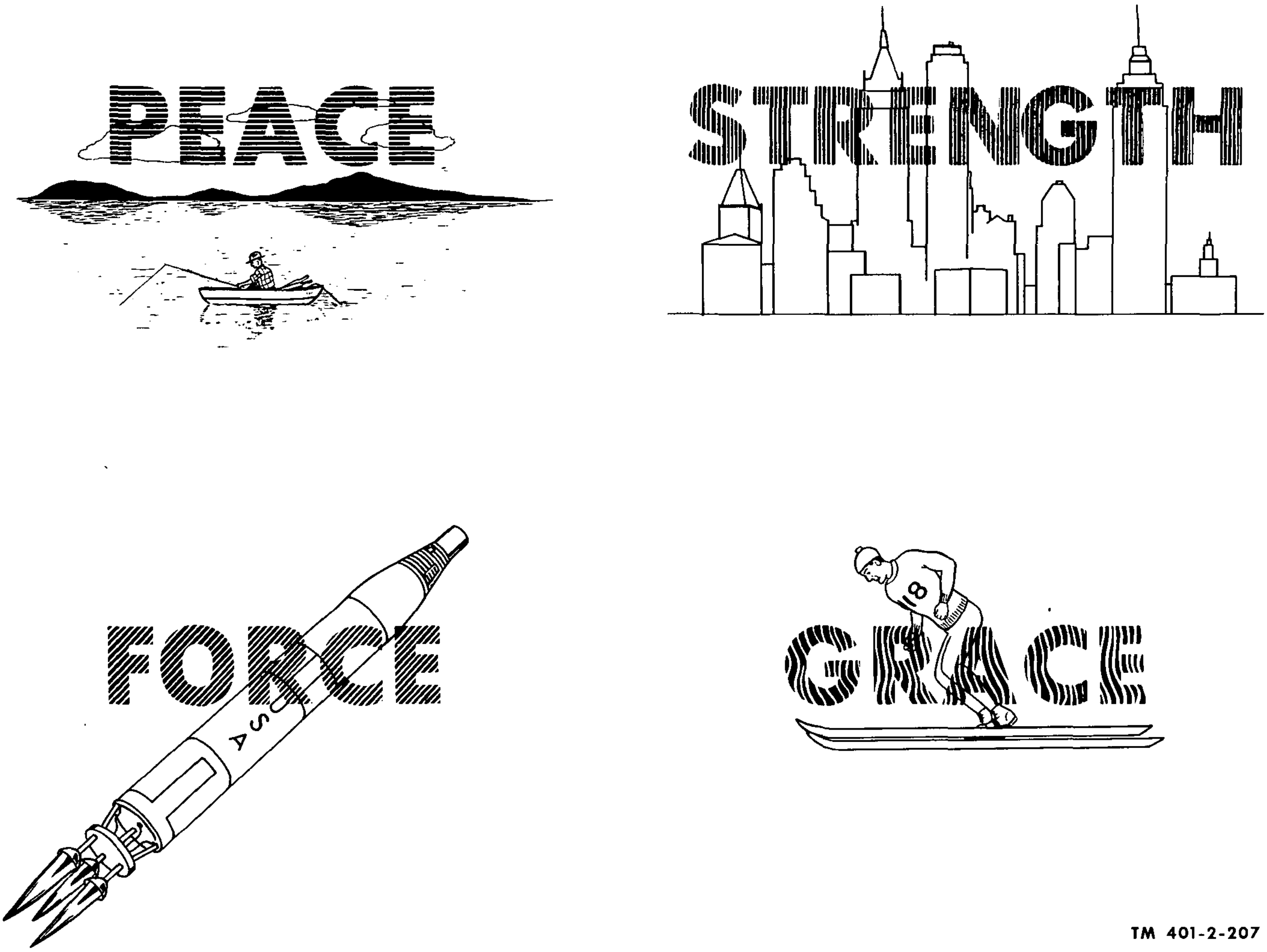


Figure 2-7. The meanings of lines.

trees, or other such item as foreground material to create the illusion of depth (fig. 2-8).

2-13. Foreground Sets the Scene

The foreground should support the subject, set the scene, and create the illusion of depth; therefore, it must be in sharp focus and have sufficient depth. Objects in the foreground should not distract from the subject but should lead the viewer to the center of interest. With these facts in mind, let's analyze the photographs in figure 2-9.

a. The grass area in front of the building in A of figure 2-9 is the foreground. It supports the subject (the building) and sets the scene because it gives the subject and the viewer something in common, a place to stand. The grass area also allows the viewer to become part of the picture and gives the picture depth by showing that the building is landscaped and set back from the road.

b. In B of figure 2-9 we have eliminated the grass area and have thus changed the photograph completely. This photograph leaves the viewer up in the air wondering what's between him and the building and where he would stand if he were in the picture. We no longer have a "scene" because there is nothing to support the subject, and we have lost the illusion of depth. The main entrance and the left side of the building both appear to be the same distance from the camera. In A, however, you can see that the main entrance is farther from the camera than the left side of the building.

2-14. Background Completes the Scene

The purpose of the background is to provide a setting for the subject and, more important, to make the subject stand out. Therefore, the background should be of a tone that contrasts with the subject and should be positioned so that it does not reach into the subject.

a. Background Contrast. There should be enough contrast between the subject and background to highlight the subject. If you position

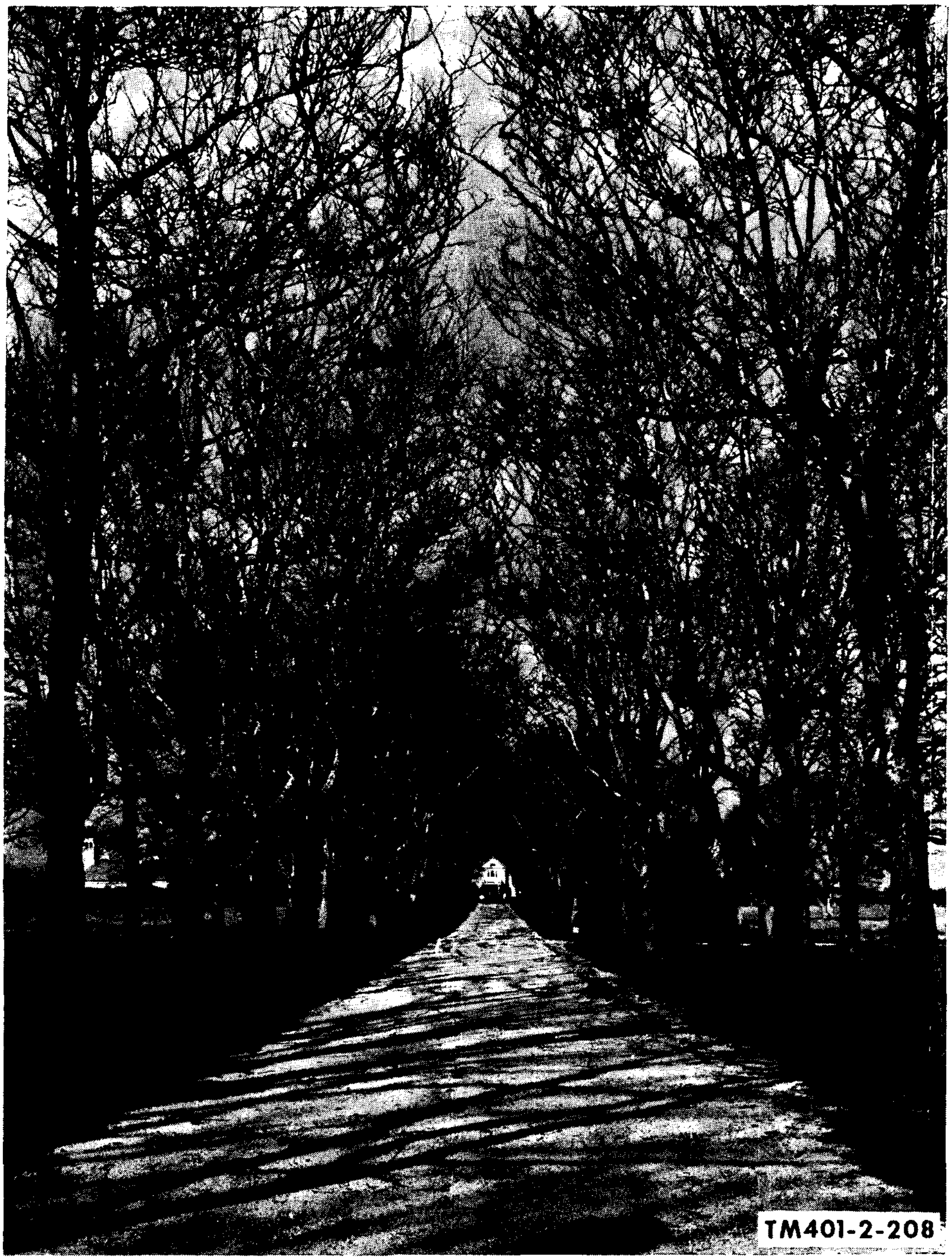


Figure 2–8. Depth.

the subject against a bright sky you will increase the contrast but lose a great deal of subject detail. This is good for a silhouette but not for subject detail.

b. Background Detail. Fine detail in the background is undesirable because such detail might command the viewer's interest. Use a neutral gray background to get more subject detail and to minimize background detail. You might even need to put the background out of focus in order to reduce the sharpness of the detail there.

c. Background Tone. Although fine background detail is undesirable, a solid single gray tone is worse. Use clouds, hills, and distant forests to break up this solid tone and to present a better contrast between background and subject.

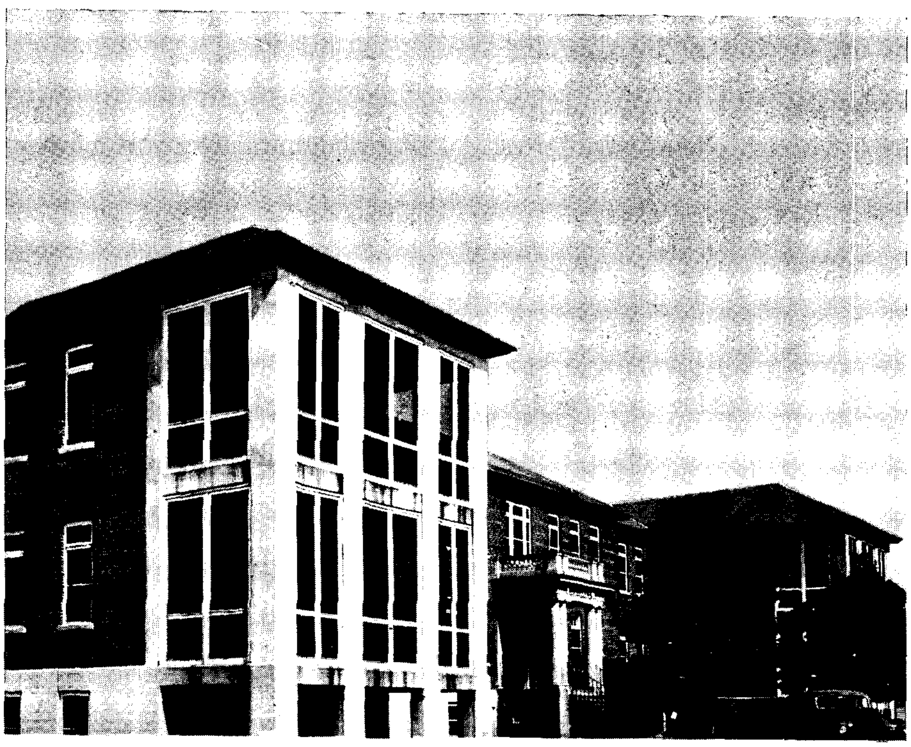
d. Background Positioning. Consider the effects of the background and place the subject accordingly. A tree growing out of a man's ear, a soldier lifting a tank over his head, and a man jumping over a building are just a few examples of the many humorous photographs you can make if you do not position the subject properly. This type of trick photography has its place, but do not allow it to spoil your photographs.

2–15. Frame the Subject

Occasionally, foreground objects will serve as

FOREGROUND OF PROPER DEPTH

A



LACK OF SUPPORT DUE TO INSUFFICIENT DEPTH
OF FOREGROUND

B

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Figure 2-9. Foreground.

a frame for the subject you are photographing; *for example,* a gateway may frame a building, or tree branches may frame a sniper's eyeview. However, this doesn't happen very often. It is your responsibility to leave a narrow band that will serve as a frame around the subject or idea you photograph. Figure 2-10 illustrates this idea of framing a subject.

a. C of figure 2-10 is an example of proper framing. The photographer left enough space between the tree and the edges of the print to allow the viewer to see the complete tree in its environment without too much background detail. In A of figure 2-10 there is too much frame around the tree. As a result, there is too much background detail; the other trees detract from the subject. In B there is too little space around the tree. Actually, in trying to photograph only the tree, the photographer cut off the top of it.

b. You must also consider the dimensions of your picture and subject when you frame your photographs. The longer dimension of the picture should correspond to the longer dimensions of the subject. *For example,* the tree in figure 2-10 is taller than it is wide; therefore, the photograph of that tree is taller than it is wide.

2-16. The Camera Angle Alters Character

The camera angle you use has a direct relationship to the character of the photographs you produce. If you want to produce a scene much the same as your eyes see it, you should photograph that scene at eye level, which is the most natural level of view for you. Eye level is also the most natural angle of view for the camera and is the angle you should use most often. To change the characteristics of your photographs, change the camera angle. *For example—*

a. Straight Ahead. Point the camera dead straight at the front of the subject for copywork. Use this camera angle to photograph two-dimensional objects, but do not use it when the subject contains body because it produces a dull, flat picture (A, fig. 2-11).

b. Right or Left. If you must photograph a subject from the front, angle the camera slightly to the right or left so the viewer can see two sides of the subject. This adds depth and reality to the photograph. Compare A and B of figure 2-11.

c. Looking Down. The apparent height of an object decreases when you look down on that object. Therefore, photograph from a high level looking down on the subject to make the subject look short and to make the viewer feel superior (C, fig. 2-11).

d. Looking Up. If you look up at an object, the apparent height of that object increases. Therefore, photograph from a low level looking up to make the subject appear tall and majestic and to make the viewer feel small and inferior (D, fig. 2-11).

2-17. Using the Rules of Composition

The following are a few hints on using the rules of composition to photograph specific subjects.

a. Landscapes. You can only partially control

Figure 2-10. Framing.

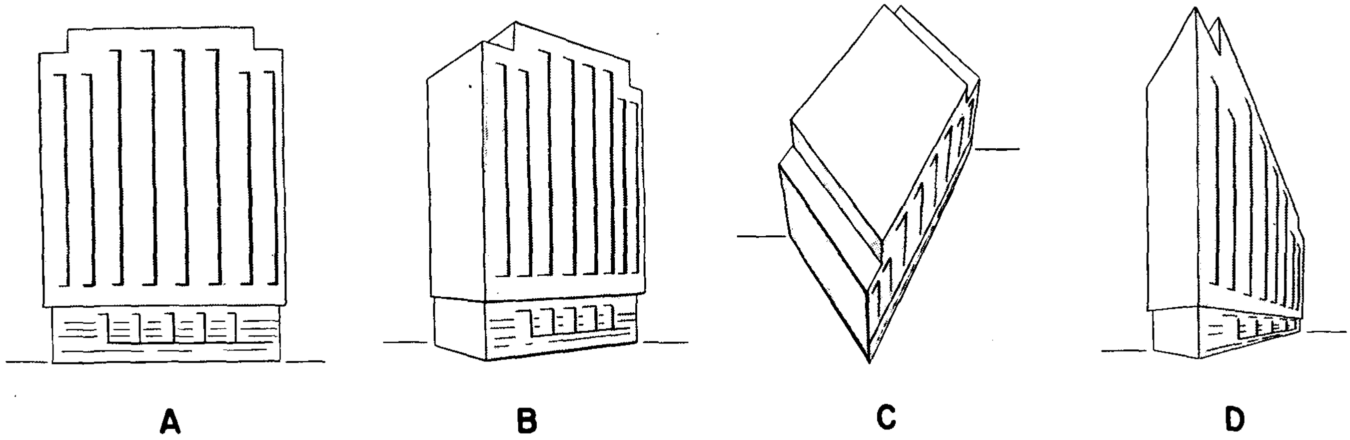

Figure 2-11. Camera angles.

lighting and actual subject placement in landscape photographs; therefore, you govern the composition of such scenes by camera viewpoint and selection of lens focal length. Choose a viewpoint that will encompass all the necessary terrain features as well as the proper frame and foreground. Since the direction and amount of light and shade are controlled by the time of day, select a time when the texture of the landscape details are most prominent. Use sidelight for contrasting details when your photograph is to be used for critical analysis of the terrain.

b. Buildings. When you photograph a building, select a viewpoint that will show the front, just enough of one side to indicate depth, and just enough foreground to indicate the grounds and approaches. Do not allow a tree or bush to hide the entrance or a corner of the building to divide the picture in half. Use mid-morning or mid-afternoon light to bring out architectural details.

c. Mechanized Equipment. Photograph tanks, armored vehicles, trucks, and artillery from one side but at a front angle to show width and important frontal features. A waist-level viewpoint shows the equipment to its best advantage. Front lighting is preferable for even illumination. Keep the background plain and simple, perhaps even out of focus. The doors and windows of the equipment should be closed, and the equipment should look as neat as possible. Have the subject appear to be entering the photograph by placing the rear of the equipment nearer to the margin of the photograph than the front.

d. Aircraft. Photograph airplanes from a low angle with more of a side view than a front view. The low angle will give lift to the airplane to make it look as if it belongs in the sky. Include a large area of sky and use a filter to dramatize the clouds or darken the sky for this same reason. If you include flight personnel or mechanics you will reduce the mechanical coldness of the subject and give an impression of its size; however, any people in the photograph should be doing something with or on the machine. If you place people in the foreground they will distract the viewer from the aircraft because the plane will appear smaller than they are.

2-18. Review of Rules of Composition

With the missing words supplied, the following is a summary of the rules of composition discussed in this section. You supply the necessary words and then check with the answers in paragraph 2-59.

a. The rules of good composition (are, are not) hard-and-fast laws and may be altered to fit the situation.

b. Each picture should present ____________ idea.

c. Each picture should contain (less than, just, more than) enough detail to serve the purpose of the picture.

d. There should be ____ (number) center of interest.

e. The center of interest should be __________ from one side and ____________ from either the top or bottom of the picture.

f. The photograph (should, should not) be balanced).

g. Objects of equal size placed symmetrically produce a ____________ photograph.

h. Objects of unequal size can balance a picture if the smaller object is placed ____________ from the point of balance than the larger object.

i. The picture area (should, should not) be divided into two equal areas.

j. The horizon should be ______________ from either the top or bottom of the picture and not in the ____________.

k. The picture should have direction lines that lead the eye to the ____________.

l. Lines give character to the photograph and support its purpose. Horizontal lines indicate __________, vertical lines indicate __________, slanted lines indicate ____________, and curved lines indicate ____________.

m. Tonal separation is the difference in the ____________.

n. The picture should have ____________ to give realness.

o. The foreground should support the subject, set the __________, and aid in the __________.

p. The background should not interfere with the subject being presented and should not have ____________.

q. A border of picture area should __________ the scene.

r. The camera is normally held at __________ level, for its should view the subject at an angle —looking right or left for depth, looking down to ____________ the subject or looking up for ____________.

Section III. PERSPECTIVE

2–19. Perspective, an Illusion of Depth

Photographs have only two dimensions, height and width, but they can also have the illusion of a third dimension, depth. This illusion of depth is created by image size, image position on the picture, relative position of images to one another, and by the fact that some normally parallel lines are not parallel in the photograph. To bring life and realness into your pictures use the concepts discussed in *a* through *e* below.

a. Just as the eye sees distant large objects as small images, the camera also automatically reduces the image size to correspond to the distance of the object from the camera. Consequently, a man in the foreground of your photograph may appear much taller than a building in the background. Although the camera does the image reduction, do not leave everything to chance. If you improperly place the subject and camera, the resulting photograph could trick our eye into seeing the man in the preceding examples as a giant standing next to the building.

b. An image on a photograph appears to be farther away the closer it is to the horizon. Thus, a truck on a small rise will appear farther away if the terrain and surrounding features do not clearly indicate distance.

c. A third method of getting distance into the picture is to hide part of the distant object. Our eye cannot see what is behind an object; thus, a man standing in front of a tree hides part of the tree and makes the tree seem (as it really is) farther away than the man.

d. Because an image gets smaller as an object gets farther away, there must be some distance where the image gets so small it vanishes. This is what happens when the sides of a road, which are actually parallel, meet at some point in the distance on a photograph and the width of the road gets smaller until it vanishes as shown in figure 2–12.

e. All parallel lines that run away from the camera form lines on a photograph that converge. The point of convergence, where lines meet and image size disappears, is called the vanishing point. We know from experience that some lines are parallel—lines such as road sides, railroad tracks, and certain edges of buildings. Seeing lines that we know are parallel converge on a photograph gives the illusion of distance. This illusion is perspective.

2–20. Film Position Affects Perspective

a. Parallel lines that are parallel to the film will produce parallel lines on the print. In figure 2–13 we're photographing a block whose front (F) is parallel to the film. Thus, the opposite edges of the front of the block are parallel on the print.

b. In the same print (fig. 2–13), the top and bottom edges of the sides (S) of the block appear to converge on the vanishing point just as the side edges of the top (T) appear to converge. These lines, if extended, meet because the edges of the object were not parallel to the film and thus, on the print, converge on a vanishing point.

c. Note that in figure 2–13 all the vertical lines are parallel on the print. If you tilt the camera up or down the vertical edges of the block will no longer be parallel to the film and they will converge on the print. Thus, you can change the perspective by changing the position and viewing angle of the camera.

Figure 2-12. Vanishing point.

2-21. Viewpoint, Viewing Angle, and Perspective

a. Figure 2-14 shows the results of photographing a cube from various angles and positions. Each row across shows how the cube appears from one position, and each column down shows a particular viewing angle. *For example,* the figure in the top right corner shows what is seen by a camera placed directly in front of the cube but looking down at a point below the cube.

b. The view shown in the first row, first column completely lacks perspective. It's flat, lacks depth, and is generally undesirable.

c. The third column of figure 2-14 shows views with the camera looking down, causing all the vertical lines to converge at a point below the cube. If the camera were looking up, the vertical lines would converge above the cube. In either case, the view is usually undesirable because our eyes do not normally see vertical lines as converging lines.

d. The most natural view shown in figure 2-14 is the one in the lower left corner. The middle view in the bottom row would also be a good view if the lens-to-subject distance were greater.

2-22. Distance Affects Perspective

a. The closer the camera is to the object being photographed, the greater the effect of perspective. That is, if you photograph two objects, one behind the other, the back object will be much shorter than the front object when the lens-to-subject distance is short. The two objects will be about the same size when the lens-to-subject distance is long. The difference in image size between the two lines shown in figure 2-15 is much greater when the camera is close to the lines than when the camera is far away.

b. For the effect of lens-to-subject distance on the illusion of distance, note how much farther away the house over the MP's right shoulder appears in the top photograph than in the bottom photograph in figure 2-16. The focal length of the lens was changed in producing the two photographs to keep the image size the same.

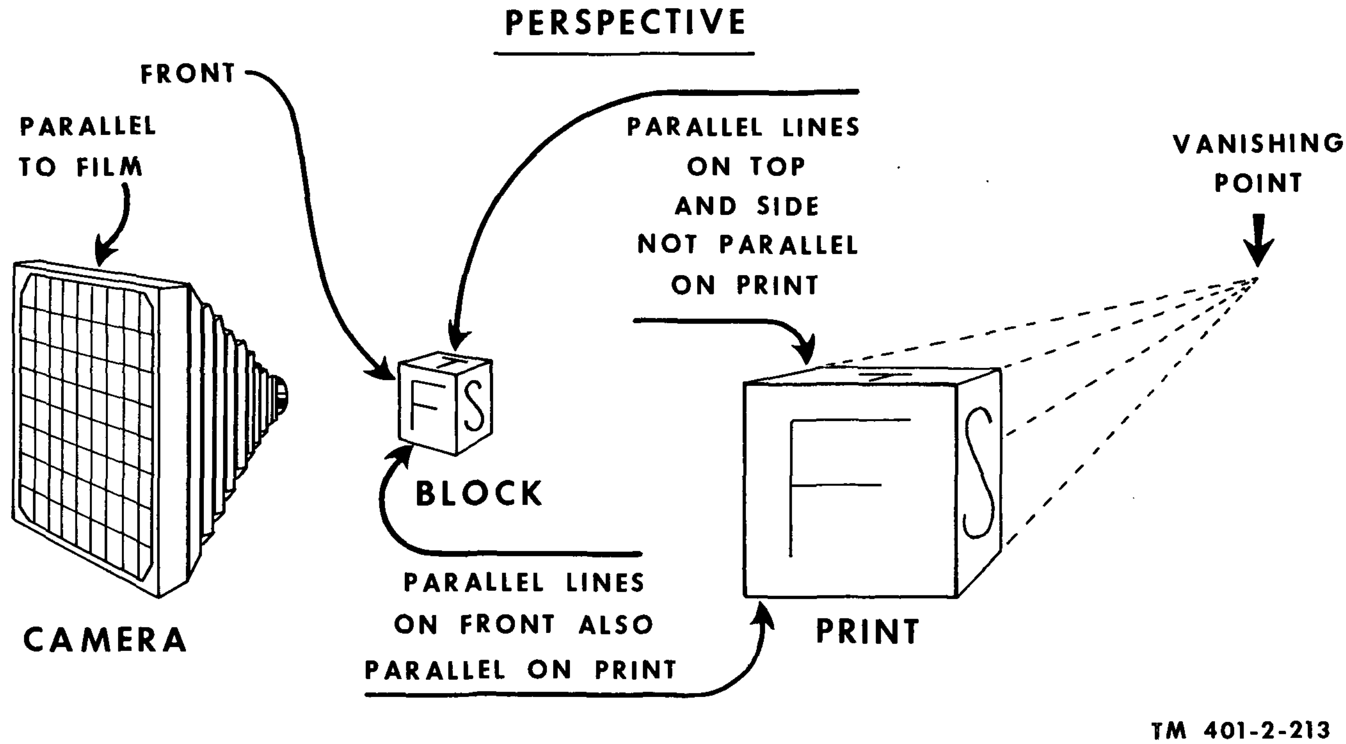

Figure 2–13. Perspective.

c. Increasing the lens-to-subject distance reduces the stress on perspective but also reduces the image size. The relationship of the image size (I) to the object size (O) is given by the formula—

$$\frac{I}{O} = \frac{F}{D-F}$$

where D is the lens-to-subject distance and F is the focal length of the lens. This relationship says that an object photographed with a 6-inch lens at 5½ feet has an image to object ratio of—

$$\frac{I}{O} = \frac{6 \text{ in.}}{5.5 \text{ ft}-6 \text{ in.}} = \frac{6 \text{ in.}}{66 \text{ in.}-6 \text{ in.}} = \frac{6 \text{ in.}}{60 \text{ in.}} = \frac{1}{10}$$

or that the image will be one-tenth the size of the object. If the object is a man 5 feet tall, the image would be one-tenth of 5 feet (0.5 feet=6 inches).

2–23. Focal Length and Perspective

a. Changing the focal length of the lens does not change the actual perspective. It may, however, change the apparent perspective because the camera does not see as much of the scene with a long focal length as it does with a shorter focal length. In effect, a long focal length lens increases image size (more detail of objects), shortens apparent distance, and reduces the field of view (fig. 2–17).

b. Angle of field is a measure of the area that a lens can see and effectively focus on the film plane. Its value, in degrees, is equal to the separation of two light rays passing through the optical center of the lens and striking opposite sides of the area of usable illumination on the focal plane (fig. 2–18). Since the film is normally kept within the area of usable illumination, the scene reproduced is less than what the lens can see.

c. Angle of view is a measure of the area that the film sees. It is the angle between lines that connect opposite corners of the film to the optical center of the lens (fig. 2–18).

d. For what is considered normal perspective, the diagonal of the film should be equal to the focal length of the lens. This gives an angle of view of about 50 degrees. For an angle of view greater than 55 degrees, the focal length must be shorter than the diagonal as it would be with a wide-angle lens. A telephoto lens has a focal length greater than the film diagonal, giving an angle of view less than 45 degrees.

e. Table 2–I shows the angle of view for various focal lengths and film sizes. Note how the angle of view decreases with increase in focal length and how the angle of view increases with increase in film diagonal. Using table 2–I, an-

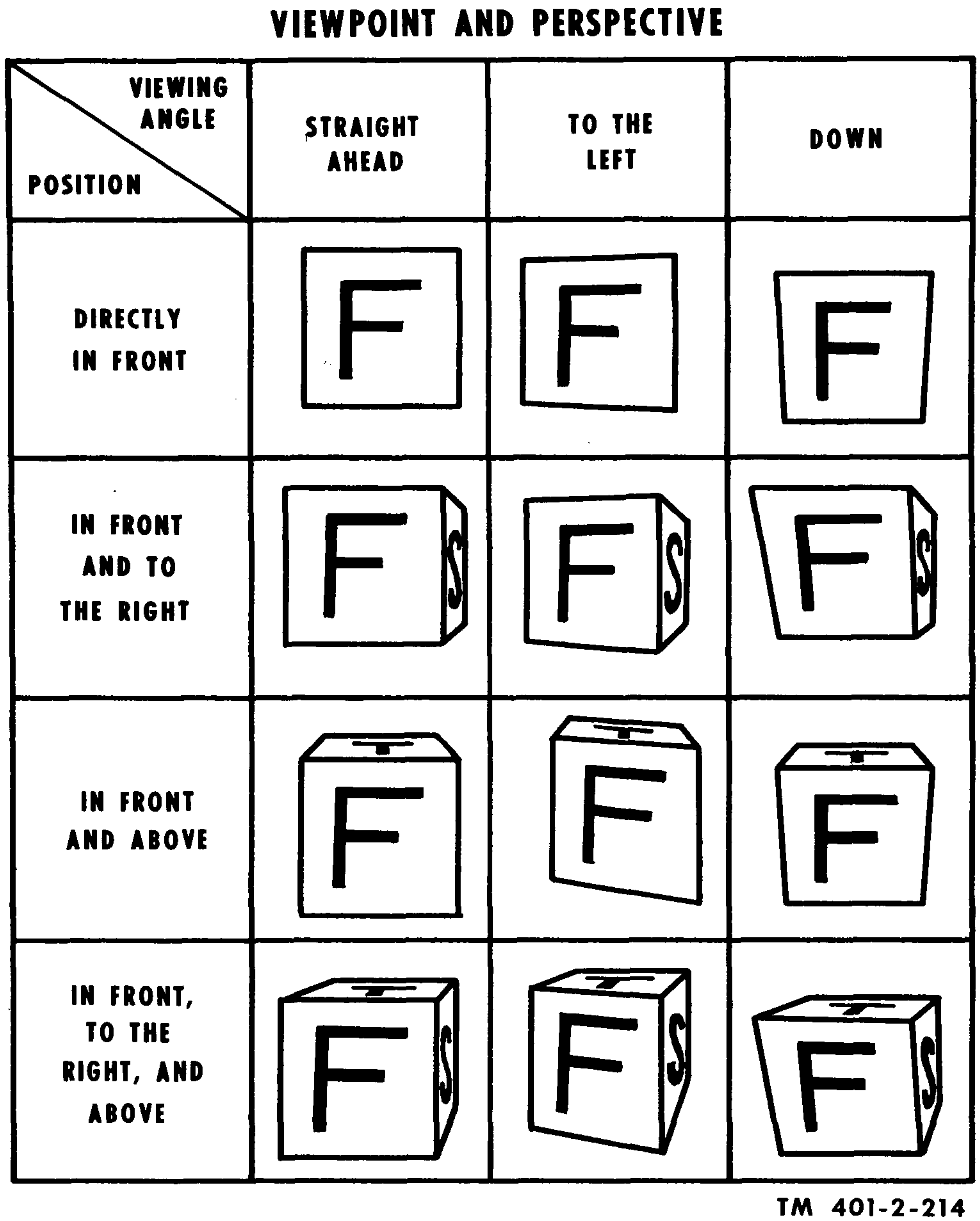

Figure 2-14. Viewpoint and perspective.

swer the following questions. How much does the angle of view decrease as we switch from a focal length of 2 inches to a focal length of 3 inches on a 35-mm camera? How much does the angle of view increase for a 4-inch lens if we increase the film diagonal from 43.2 mm to 162 mm?

f. If you said 14 (46 minus 32) and 53 (77

Table 2-I. Angles of View

Type of camera	Negative size			Focal length of lens									
	Length and width		Diagonal	in. 1	1⅜	2	3	4	5	6	7	8	10
	in.	mm	mm	mm 25	35	51	76	102	127	152	178	103	154
							Angle of view of lens (degrees)						
35 mm	1 x 1½	24 x36	43.2	81	63	46	32	24	17.7	16	13.8	12	
Pressview	4 x 5	101 x 127	162				93	77	65	56	49	44	35
View	8 x 10	203 x 254	325						103	93	85	77	65

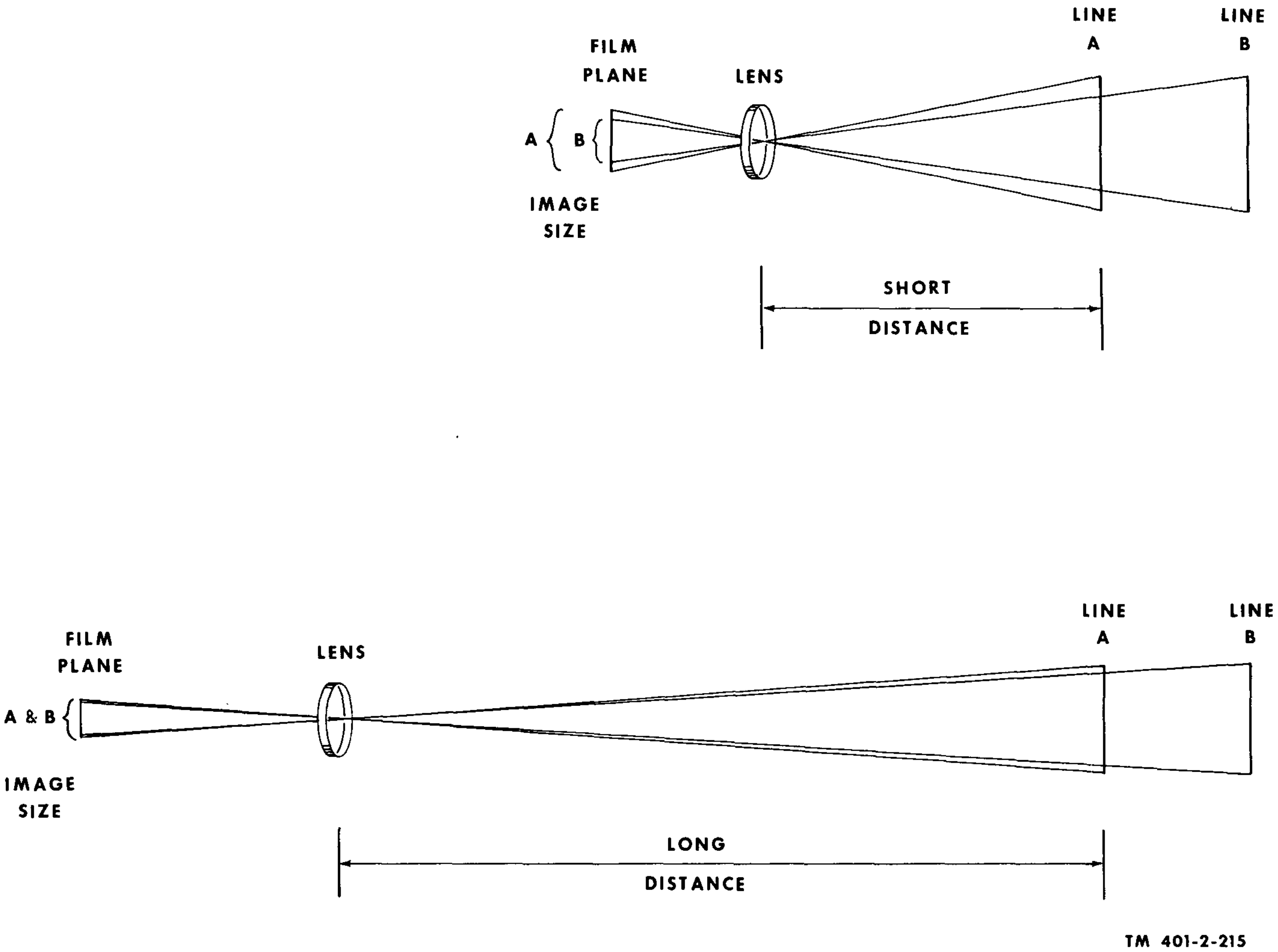

Figure 2–15. Distance and perspective.

minus 24) degrees respectively for the answers to the above questions, you are correct.

2–24. Selecting Distance and Focal Length

You should position your camera just far enough from the subject to include all of the scene you want plus a little more for framing. Thus, the lens-to-subject distance depends on the angle of view.

a. Normal lenses have an angle of view of about 50 degrees because the focal length is about equal to the diagonal of the film. When you have to choose between a lens that is slightly longer than the diagonal and one that is slightly shorter, select the longer lens. This permits you to work farther away from the subject, assuring better perspective and more convenient operating space.

b. Wide-Angle lenses have short focal lengths and an angle of view greater than 55 degrees. Consequently they include much more of a scene than a normal lens would. This enables you to work much closer to the subject. But remember, working close to the subject places a greater stress on perspective and apparently increases the illusion of distance, so you should avoid this if possible. However, a wide-angle lens is very useful if you are working in cramped quarters and when your assignment directs you to include as much of the scene as possible.

c. Telephoto (or long focal length) lenses have an angle of view less than 45 degrees and do not include as much of the scene as a normal lens would. Distant objects are recorded larger, thus showing more detail. Perspective is not accentuated; therefore, distances appear to be shortened. The shortened distance may make background objects appear to be part of the subject. Perspective is more natural with a long focal length lens, but the viewer should look at the print from farther away than a print taken with a short focal length lens.

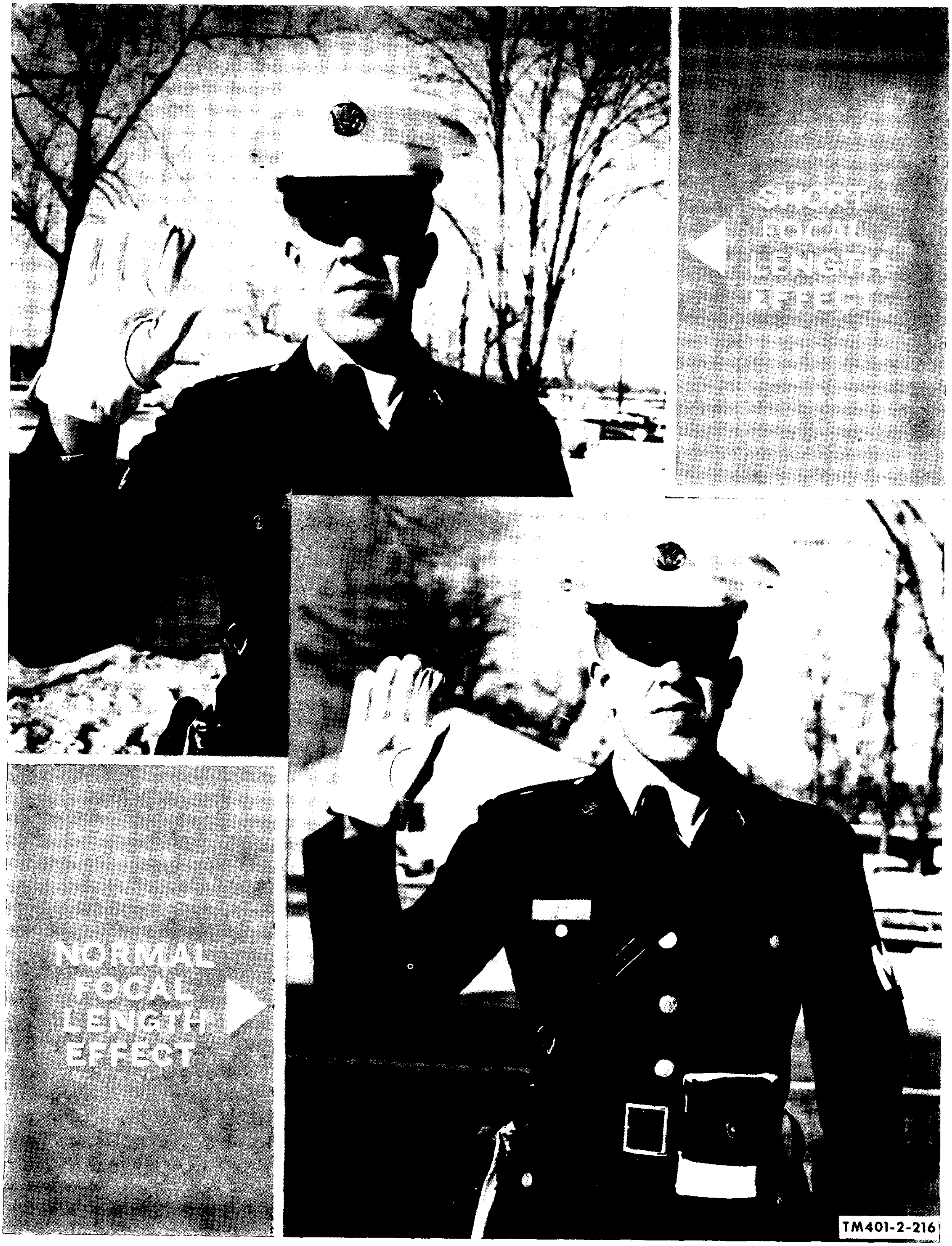

Figure 2-16. Distortion and distance.

Figure 2-17. Long focal length effect.

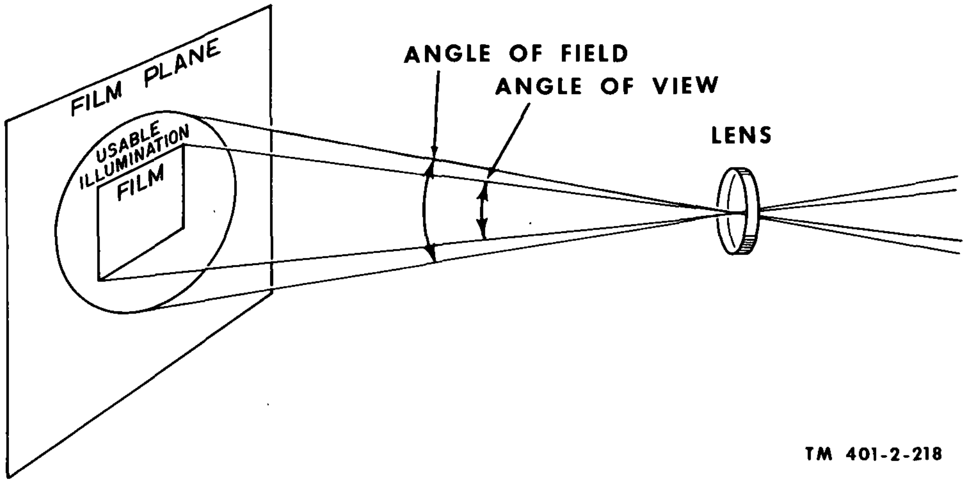

Figure 2-18. Angles of view and field.

2-25. Viewing Distance Related to Focal Length

a. A contact print made from a photograph taken with a 6-inch lens should be viewed from 6 inches. You should hold a contact print 10 inches from your eyes if the photograph was made with a 10-inch lens. In general, the viewing distance of a contact print is equal to the focal length of the lens used, in order to see the proper perspective.

b. If the print is an enlargement, then you should increase the viewing distance the same amount. A print that was taken with a 3-inch lens and enlarged five times should be viewed from 15 inches. The correct viewing distance is the simple mathematical formula—

$$L = nf$$

where L is the viewing distance, n is the magnification, and f is the focal length.

c. A person with normal eyesight holds the page about 10 inches from his eyes to read a book or view pictures. Table 2-II shows how much enlargement is required to get a viewing distance of 10 inches. This chart shows that when a 4-inch lens is used, a print must be magnified 2.5 times for the recommended viewing distance. How much enlargement is required for a 6-inch lens?

Table 2-II. Magnification for 10-Inch Viewing

Focal length of lens (inches)	Amount of enlargement
1.4	7
2	7
2.8	3.57
3.6	2.77
4	2.5
5	2
5.4	1.85
6	1.66
9	1.11
10	1

d. An exposure made with a 6-inch lens requires an enlargement of 1.66 for a normal viewing distance of 10 inches.

2-26. A Summary of Perspective

The following sentences summarize the material covered in this section when you have filled in the blanks with the few words that have been omitted. The answers are in paragraph 2-60.

a. The illusion of depth in a photograph is created by image size, image placement, and ____________.

b. Distant objects appear ____________.

c. Objects near the horizon appear ___________.

d. Images partly hidden by other images appear ____________.

e. Parallel lines that are parallel to the film produce ____________ lines on the print.

f. Parallel lines that are not parallel to the film plane appear to ____________ on a distant point called the ____________ point.

g. Tilting the camera up or down produces the unpleasant perspective that causes ________ lines to converge.

h. When the camera is too close to the subject the perspective is exaggerated and the picture ____________.

i. Increasing the lens-to-subject distance improves the perspective but ______________ the image ____________.

j. Increasing the focal length does not actually alter the perspective, but because of increased ____________ and decreased ____________ there is an apparent change in perspective.

k. The normal lens has a focal length equal to the ____________ of the film and an angle of view of about ____________ degrees.

l. A wide-angle (short focal length) lens has a focal length ____________ than the diagonal of the film, an angle of view ____________ than 55 degrees, and is used mainly in cramped quarters.

m. A telephoto (long focal length) lens has a focal length ____________ than the diagonal of the film, an angle of view less than __________ degrees, and is used to bring out detail of distant objects.

n. A print should be viewed from a distance equal to the ____________ times the number of times it was ____________.

Section IV. SWING AND TILT ADJUSTMENTS

2-27. Camera Adjustments Control Picture Quality

Most cameras have adjustments, such as shutter speed or size of aperture, that must be set correctly to get high quality pictures. TM 11-401-1 discusses these factors in detail in chapter 6, section VI. In this section we'll discuss the swing and tilt adjustments found on view cameras. These adjustments allow you to change the relative position of the back (film plane) and front (lens) of the camera to control perspective, depth of field, and image placement.

2-28. Swinging the Back Controls Perspective

a. Remember, we said that perspective depends on the relationship of the subject and the film plane, that parallel lines *not* parallel to the film converge on a vanishing point, and that this gives the illusion of distance. So by moving the film plane you can alter the perspective.

b. In many view cameras you can move the film plane by moving the back of the camera. The back *swings* to the right or left, *tilts* up or down, or *rotates*. A view camera does *not* necessarily have all three motions; some have two, one, or none.

c. Rotating the back does *not* change perspective; it changes the position of the image on the film so that the film can be placed to fit the subject. That is, the image can be positioned lengthwise, sideways, or diagonally on the film.

d. Swinging moves the vanishing point in the opposite direction. Thus, turning the back so that it faces the right causes the vanishing point to move to the left. Figure 2-19 shows how this affects perspective by comparing a normal print with a print of a photograph taken with the back turned to the right. Note in figure 2-19 how swinging the back apparently turns the block on the print.

e. In A of figure 2-20, the long building was photographed at an angle. In B of figure 2-20, the building was photographed at the same angle, but the photographer, by swinging the back of the camera to the left, made the picture more like a front view.

2-29. Tilting the Back Gains Height

a. Photographing tall buildings or other tall objects from ground level can be a problem. Normal eye level is about the same height as the first story windows, which usually appear near the middle of the picture.

b. If you get too close to the structure you may lose the upper part in the photograph, and if you get far enough away to include the whole structure the image will be small and you'll include too much foreground (A and B, fig. 2-21). Also, you may not be able to back off far enough because of obstacles such as trees or other buildings.

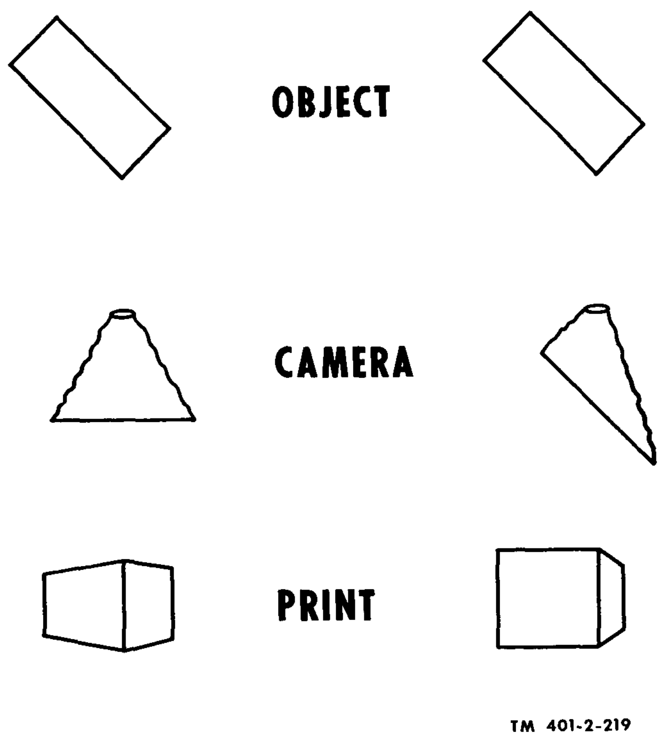

Figure 2-19. Swinging the back to the right.

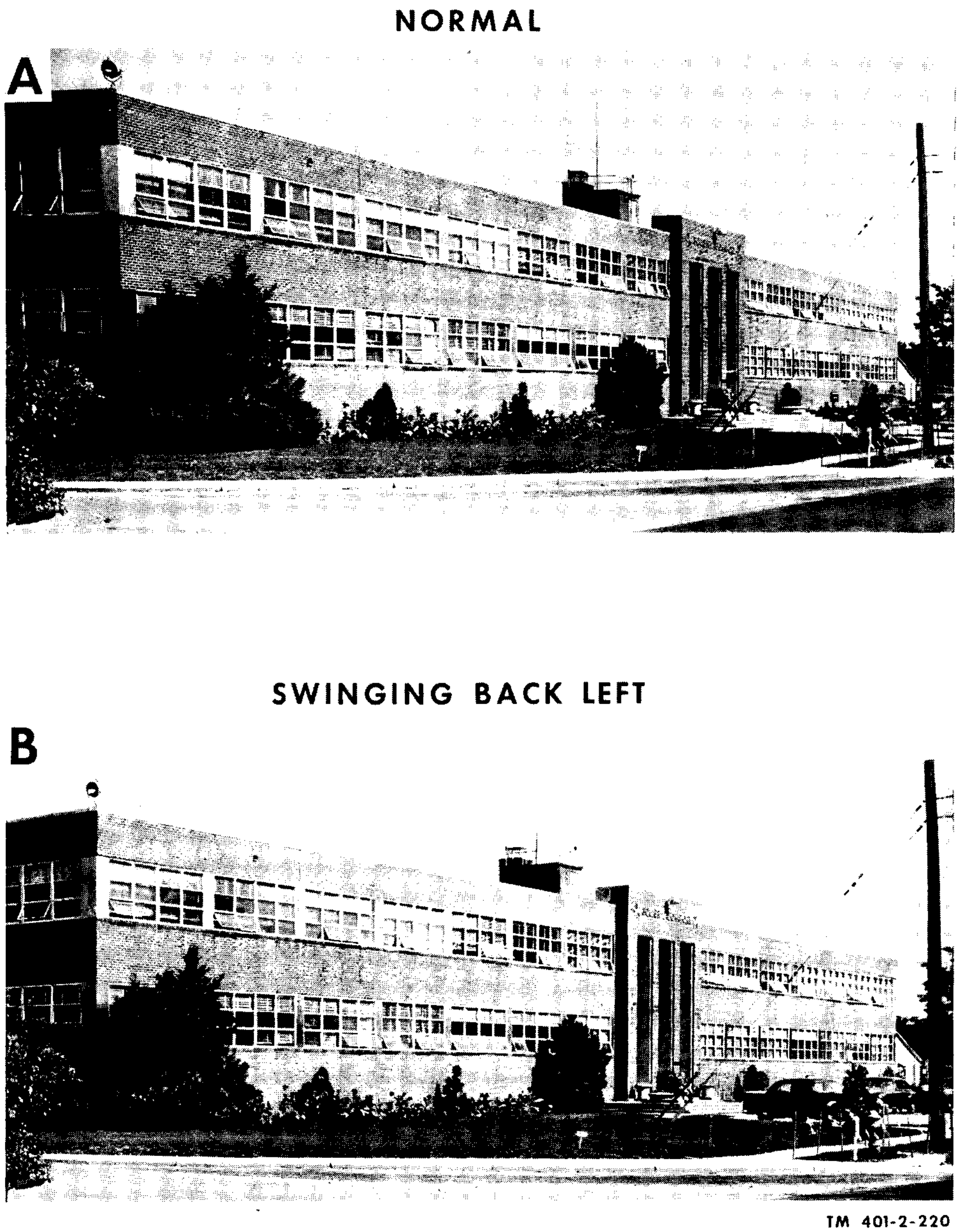

Figure 2–20. Swinging the back to the left.

c. One method of overcoming these difficulties is to stand close to the structure and tilt the back of the camera or simply point the camera up to about the middle of the structure. Tilting the back changes the perspective just as swinging the back does. Thus, the one disadvantage of this method is that all the vertical lines appear to converge toward a point at the top of the structure as shown in C of figure 2–21.

d. A better method of photographing tall objects is to point the camera up at about the middle of the structure and tilt the back forward so that the back is in a vertical position. Pointing the camera up allows you to photograph the whole object, and keeping the back vertical retains the proper perspective. This method is shown in D of figure 2–21.

e. Figure 2–22 compares by actual photographs the results of tilting the camera and keeping the back vertical (B) with just tilting the camera (A).

2–30. Raising the Front Moves the Image

a. Raising the front (lens) of the camera produces the same effect as tilting the camera without tilting the back. The image moves up on the film when the front is raised. Because the image is upside down on the film, more of the top and

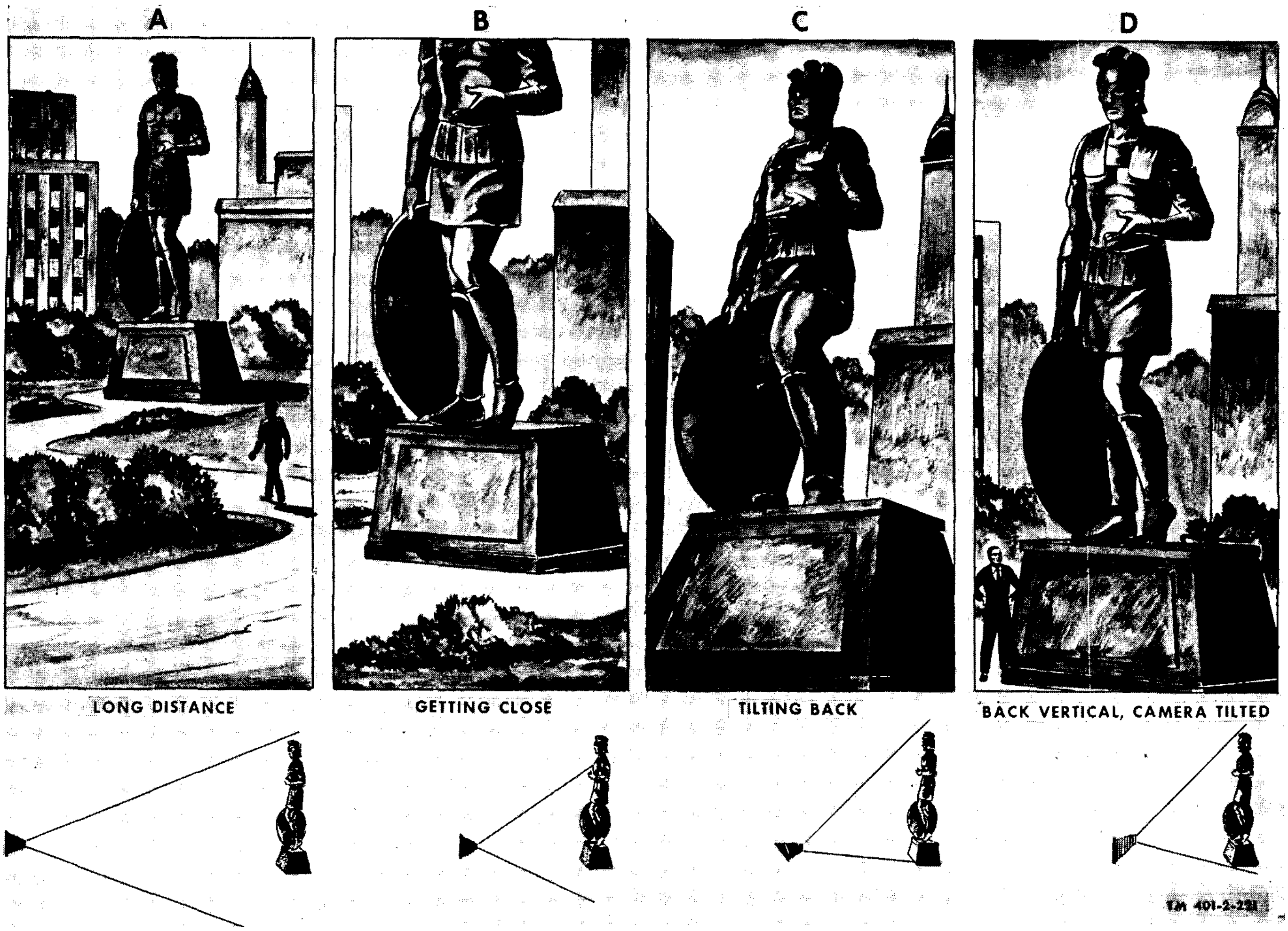

Figure 2-21. Tilting the back.

less of the bottom of the scene show on the film when the lens is raised.

b. Figure 2-23 shows that when you photograph an object with the lens and film in their normal positions, the top of the object may not show on (the bottom of) the film. By raising the lens you raise the image on the film, and you can then photograph the whole object.

c. Raising the front only moves the image. It does not change perspective or depth of field.

2-31. Swinging or Tilting the Front Controls Depth of Field

Swinging or tilting the front (lens) of the camera increases the depth of field. To see why this is so, let's review some facts about focus and depth of field.

a. You know that when you photograph a scene only one plane of the scene is in true focus. Points behind the plane actually come to focus between the film and the lens. And points in front of the plane actually come to focus behind the film. Thus, each point behind or in front of the plane of focus is reproduced on the film as a spot (meaning a point out of focus) rather than a point. This is shown in figure 2-24.

b. As long as the image of a point is smaller than the allowable circle of confusion we say that the point is in focus. In other words, the point may not be focused exactly on the film but it's close enough. So we can say there are points in front and behind the focal plane that are in focus. The distance from the nearest point in focus to the farthest point in focus is called the *depth of field,* and all points within this field are in focus.

c. Tilting the lens away from the near point, point A in figure 2-24, and toward the far point, point B, moves the points of focus for both these points toward the film plane. When the lens is tilted to the correct angle, both points will come to focus on the film plane. The correct angle of tilt is when the film plane, lens plane, and plane of the subject all meet at the same place as shown in figure 2-25.

d. Tilting the lens causes the focal plane to tilt in the same direction as the lens plane, but the

Figure 2-22. Vertical and tilted back.

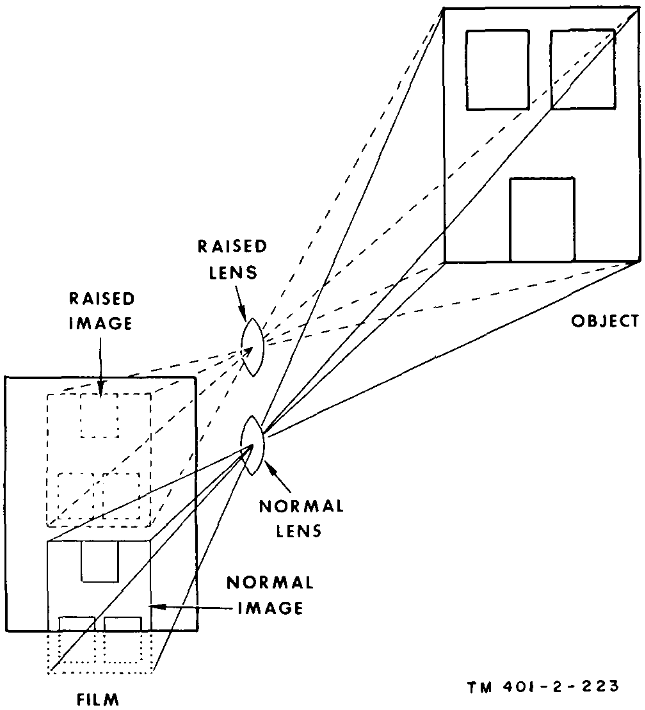

Figure 2-23. Raising front effect.

focal plane tilts faster than the lens plane. Consequently, a slight tilt of the lens produces a large tilt in the focal plane.

e. Since the field of focus covers a distance in front and behind the focal plane, we effectively increase the depth of field when we tilt the lens. We say "effectively" because the field of focus is also tilted. A tall object standing in the foreground might be in focus at the bottom and out of focus at the top.

2-32. Use Front Tilt for Stairs

a. To photograph a staircase without tilting the front, focus on a point one-third up the stairs because about one-third of the depth of field is in front of the plane of focus. If you use this method your depth of field might not be deep enough, resulting in the top and bottom of the staircase being out of focus as shown in A of figure 2-26.

b. Another method is to focus on a point directly in front of the camera and in the plane of the stairs, then tilt the lens slowly in the direction of the plane of the stairs. By this means both the top and the bottom of the stairs can be brought into focus at the same time. This is shown in B of figure 2-26.

c. This procedure may leave other important areas out of focus. *For example,* the top of the post in B of figure 2-26 is out of focus. Remember, there are other ways of increasing the depth of

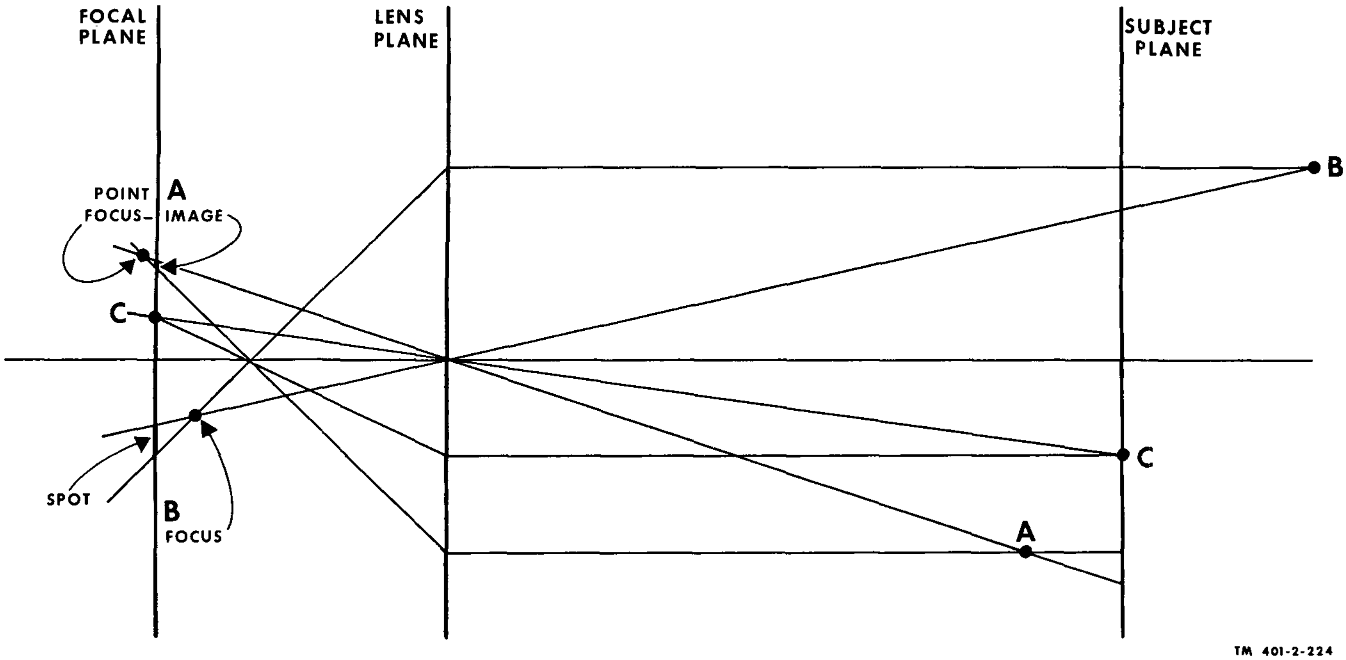

Figure 2–24. Vertical focal plane.

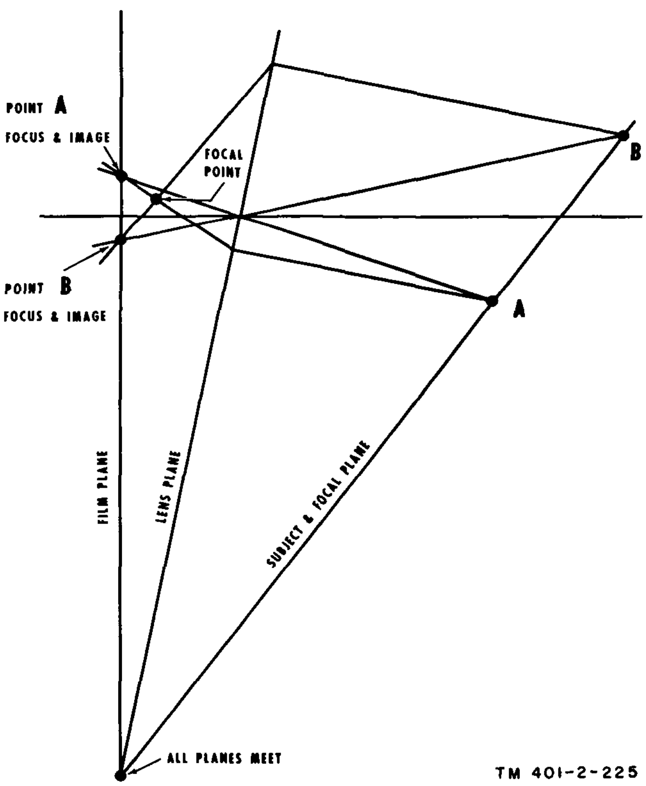

Figure 2–25. Tilted focal plane.

field such as decreasing the aperture size. Refer to TM 11–401–1 for more details on depth of field.

2–33. Angle of Field Limits Swing

a. A lens can only see as much as is defined by

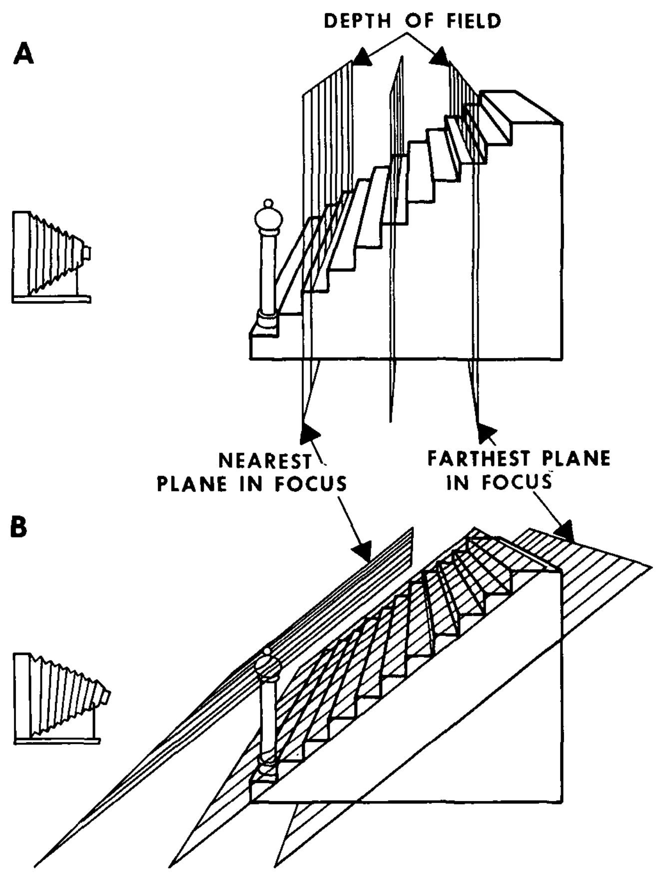

Figure 2–26. Extending depth of field.

its angle of field. And what it sees is focused on an area directly behind the lens called the *circle of illumination.* Swinging, tilting, or raising the front or the back may move the film, or part of the film, near the rim of the circle of illumination. This causes the definition to become poorer and may move the film out of the circle of illumination entirely.

b. The angle of field depends on the lens. In general we can say that the angle gets wider as the focal length gets shorter.

2-34. How to Use Swings

Using swings should not be a hit or miss matter; you must view the image as you make adjustments. Make your swing adjustments in the following order:

a. First focus on the subject.

b. Raise the front to position the image.

c. Tilt or swing the back for the desired perspective.

d. Tilt or swing the front to make the average plane of the subject correspond to the plane of focus.

e. Refocus if necessary.

f. Stop down for further increase in depth of field.

2-35. Summary of Swing Adjustments

Supply the missing words for a review of swing adjustments, and then check your answers in paragraph 2-61.

a. Swing backs are used to control ----------.

b. Swinging the back so that the film is more parallel with the front of the subject makes the print look more like a ------------ view.

c. Tilting the back up allows you to photograph taller objects but distorts the -------------- by making the sides ------------.

d. A better method of gaining height is to keep the back ------------ and tilt the camera up.

e. Raising the front is used to ------------ the image on the film.

f. Swinging the front is used to control the ------------.

g. Tilting the front causes the plane of focus to tilt in the (same, opposite) direction but with a ------------ amount of tilt.

h. The amount of swing possible is limited by the ------------.

Section V. FILTERS

2-36. Filters Improve Tone

a. Filters are used to control the amount and type of light that reaches the film. Some filters hold back a particular color of light, others block light reflected from smooth objects, and still others simply reduce brightness. You can stress or deemphasize any feature on a picture if you select the right filter.

b. Filters that prevent certain colors of light from reaching the film are used with black and white film because even black and white film is sensitive to the color of light. Film sensitivity to color is discussed in section VI of this chapter. So in this section we'll just say that two different colors *may* or *may not* produce the same shade of gray on black and white film depending on the type of film and the colors.

c. If a filter completely absorbs a color then no light of that color gets to the film and the film sees darkness (black on print). For instance, take the case where a red shirt photographs as light gray without a filter. The red shirt will be black when photographed through a filter that completely absorbs red. Normally, the filter does not *completely* absorb the color so the red shirt would show up as a darker gray.

d. Just as the colors that the filter absorbs appear darker on the print, the colors that the filter passes appear lighter.

2-37. Filters Pass Their Own Color

To select the proper filter, you need to know a few simple facts about color.

a. Out of the vast number of colors, three are the *primary* or basic colors—red, green, and blue. They are called primary colors because any other color can be formed from a combination of these three. The picture you see on a color television set is actually three pictures: one red, one green, and one blue. All the other colors you see are actually mixtures of these three colors of light. A similar process is used to produce color photographs.

b. A filter passes its own color and absorbs other colors. For instance, a red filter looks red because of the red light coming through the filter. Green and blue objects look black through a red filter because green light and blue light do not pass through a red filter.

c. Equal amounts of all three primary colors produce white, so white light is said to contain all colors. Snow looks red when seen through a red filter because only the red portion of the white light comes through the filter. The result of combining the primary colors in equal amounts is shown in figures 2-27 and 9-2.

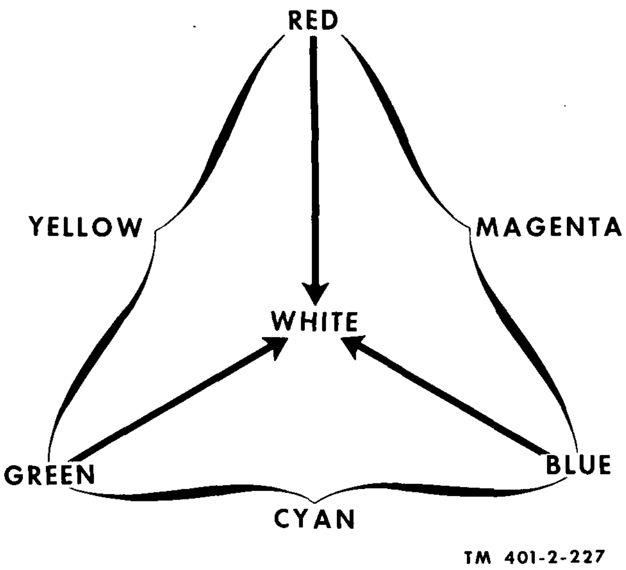

Figure 2-27. Combination of primary colors.

d. Combining two primary colors in equal amounts produces a *secondary color.* Red and green produce yellow, red and blue produce magenta (a reddish purple), and green and blue produce cyan (a light greenish blue). These combinations are shown in figures 2-27 and 9-2.

e. A filter of a secondary color will pass both the primary colors and combine to produce the secondary color. *For example,* a yellow filter passes red and green but not blue (fig. 2-28).

2-38. Complementary Colors Form White

a. Two colors that combine to produce white are said to be *complementary.* Because a combination of all three primary colors produces white, a primary color and the secondary color containing the other two primaries are complements. Red and cyan are complementary. Green and magenta are complementary, and blue and yellow are complementary.

b. A filter passes its own color or colors that make up its own color, but it does *not* pass the complement of its own color. The exact effect of a filter is more clearly indicated by its number identification and absorption curves (para 2-47) than the color of the filter. Wratten numbers form the most common numbering system for filters. The ability of a filter to absorb or pass certain colors gives you a control to compensate for film limitations, to emphasize one color, and to eliminate haze.

2-39. Filters Compensate for Film Limitations

a. Correction filters adjust the color sensitivity of the film so that the picture will look more natural. For instance, black and white film does not have the same sensitivity to all colors nor does it respond in the same manner as your eye. If you use correction filters your photograph will have a more natural appearance.

b. To make panchromatic (pan) or orthochromatic (ortho) daylight film respond more like the eye, use a yellow (K-2) filter. K-2 is the Wratten number. All film is generally sensitive to blue, and daylight contains more blue than other colors. Thus, the reason for a filter is to reduce the amount of blue light that reaches the film in order to make the photograph appear more natural. A yellow filter is used because it is the complement of blue and so it absorbs the blue color.

c. To make pan film exposed to tungsten light respond like your eye you need to reduce the blue, which the pan film is sensitive to, and to reduce the red of the tungsten light. So you should use

Table 2-III. Tone-correcting Filters

Emulsion	Film type		
	Ortho	Pan B	Pan C
Daylight	K-2	K-2	X-1
Tungsten	....	X-1	X-2

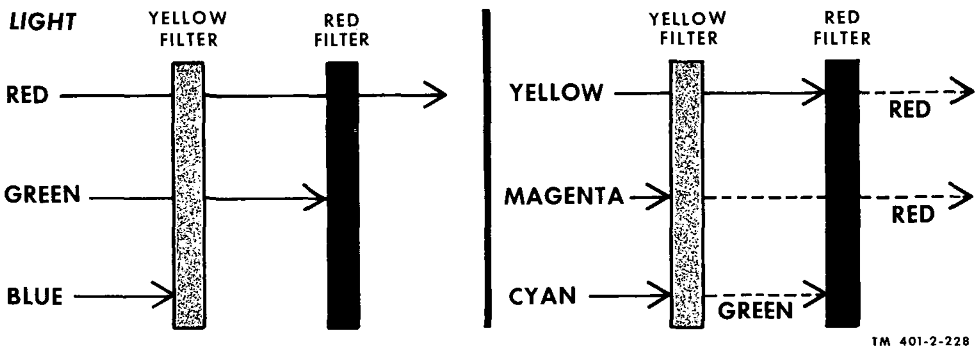

Figure 2-28. Effect of filter on color.

a light green (X-1) filter. See table 2-III for filters to use with other black and white films.

2-40. Filters Emphasize One Color

a. It's possible that two different colors reproduce the same shade of gray in a black and white photograph. If your subject and background normally reproduce similar shades of gray even though the colors are different, you can make the subject stand out by using the proper *contrast filter*.

b. Use a filter the same color as the subject you wish to lighten.

c. Use a filter the complementary color of the subject you wish to darken.

d. As an example, suppose you have red letters on a green background but there is very little contrast on the black and white print. As you can see in figure 2-29, a cyan or green filter will darken the letters and lighten the background. A red filter will lighten the letters and darken the background.

e. You can reduce as well as increase contrast by using color filters. One place where this is effective is in black and white copying when the original has a stain. In this case, use a filter the same color but slightly darker than the stain. The filter will pass only the color of the stain, so the white or gray portions of the original will appear similar in color to the stain, thus hiding the stain.

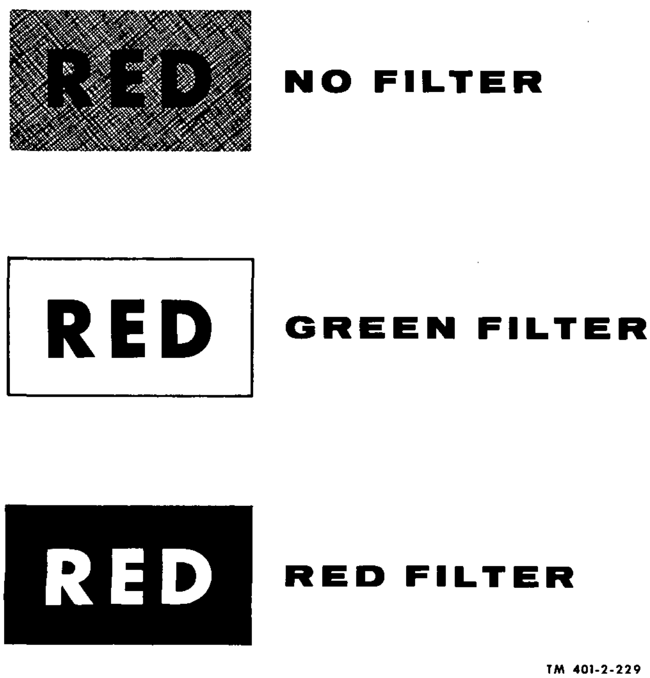

Figure 2-29. Effect of contrast filters.

2-41. Filters Penetrate Haze

a. Haze filters eliminate or reduce atmospheric haze on the negative. Haze is the blue of the sky resulting from light reflected off the moisture in the air. At short distances the amount of haze is too small to have any effect on a photograph; at long distances the haze may be too heavy to photograph hills or buildings clearly.

b. You can filter out haze because it is blue and ultraviolet light. Ultraviolet is invisible to the eye but not to the film; all films record ultraviolet light. For filtering purposes we can consider ultraviolet light as blue light.

c. Use yellow (K-2), light green (X-1), dark yellow (G), and red (A) filters as haze filters. These are listed in order of increasing effectiveness.

d. Filters cannot eliminate solid particles in the air such as dust or smoke. Anything that blocks the light of the subject will prevent the camera from seeing the subject. Haze filters block the haze light, but they do *not* increase the light coming from the subject.

2-42. Filters Reduce Glare and Reflection

A bright spot or ghostly image caused by light reflecting from a mirrorlike surface such as water, glass, or glossy, painted surfaces is usually undesirable in your photograph. A reflected image, such as trees in a quiet lake, often lends atmosphere to the picture, but at other times the reflected image is distracting, particularly when it is the reflection of a lamp you are using to light the scene, some light source that causes a very bright spot, or reflection of a window that masks the window display. Fortunately, a characteristic of reflected light, *polarization,* makes it possible to filter out the reflection.

2-43. What Is Polarized Light?

a. Besides traveling in a straight line, light vibrates from side to side, up and down, and in all directions perpendicular to its direction of travel (A, fig 2-30). When the light only vibrates in one direction (B, fig 2-30), it is said to be *polarized.*

b. Unpolarized light shining on a smooth surface is reflected as polarized light. Let's see how this happens. One part of the unpolarized light vibrating in a particular direction strikes the surface at an angle that causes the reflection. The light reflected back from the surface vibrates in only one direction and is therefore polarized.

c. Polarized light is reflected from glass, water, high polished surfaces, and even a clear blue sky. Because the light is polarized it can be filtered by a device called a pola-screen.

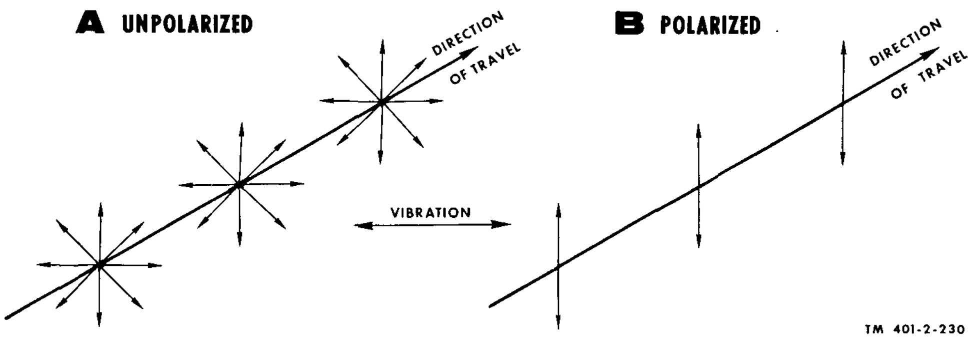

Figure 2-30. Unpolarized and polarized light.

2-44. Pola-Screens Filter Polarized Light

a. Pola-screens or polaroid filters are transparent to light polarized in one direction and opaque when the direction of polarization is rotated 90 degrees. Thus, if you rotate the pola-screen to the proper position, you can either pass or filter out polarized light. Because normal light is unpolarized, a pola-screen will only reduce the amount of normal light (fig. 2-31).

b. Pola-screens have a neutral density. That is, they have the same effect on all colors of light. Blue light passes through just as well as red (or any other color) as long as the polarization is the same.

c. A pola-screen is made of rodlike crystals lined up and embedded in plastic. The light gets through only when the vibration (polarization) is in line with the crystals. Although the actual physics is a little more complex than this, you can think of the light as a coin going into a narrow coin slot. The coin fits through the slot only when the coin and the slot are in line. To get them in line you can rotate either the coin or the slot.

2-45. How to Use Pola-Screens

a. Just as you turn the coin until it fits in the slot, you must rotate the pola-screen until it blocks the polarized light. If you use a polarizing material over your light source or if you use a filter over your lens, look at the scene as the camera will see it while you rotate the filter for the desired effect.

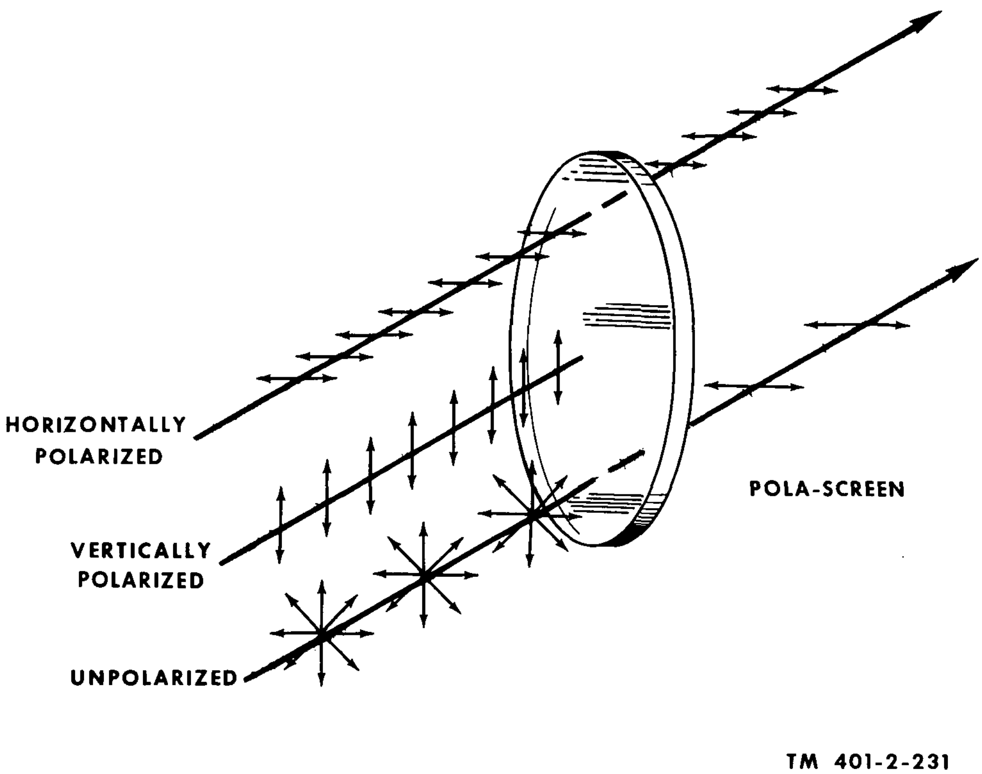

Figure 2-31. Effect of pola-screen.

b. Pola-screens are often used to control sky brightness because they reduce the polarized light reflected from the sky. Pola-screens are most effective for controlling sky brightness when the sun is at a right angle to the optical axis and least effective when the camera is looking into or away from the sun.

c. When you photograph through water or glass, use a pola-screen. Place the camera and illumination at an angle of 30 degrees to the surface to control reflections off the surface of the water or glass.

2-46. Pola-Screens Decrease Exposure

a. A pola-screen decreases the amount of light that gets to the film. It not only blocks polarized light but also reduces the intensity of unpolarized light.

b. Two pola-screens back-to-back with their crystals all lined up in the same direction act almost the same as one filter. If, however, the crystals of the second filter are lined up at an angle of 90 degrees to the crystals of the first filter, almost no light will get through the filters. And if you vary the angle, you can use the two pola-screens as a variable, neutral density filter. In other words, pola-screens control intensity of the light that reaches the film without affecting color rendition as do colored filters.

2-47. Absorption Curves Show Filter Effect

a. No filter filters out one specific color, but rather it operates over a range of colors. Even within the range of colors the effect of the filter may vary. Charts called absorption curves show the effect of the filter. Figure 2-32 shows absorption curves for some of the most common filters.

b. Since the color of light depends on its wavelength, the charts show the effect of the filter on each wavelength. The relationship of color to wavelength is as follows:

Ultraviolet	below 400 millimicrons ($m\mu$)
Blue	400 to 500 $m\mu$
Green	500 to 600 $m\mu$
Red	600 to 700 $m\mu$
Infrared	over 700 $m\mu$

c. The white part of each chart indicates the light that passes through the filter, and the gray part shows what is absorbed. Note in figure 2-32

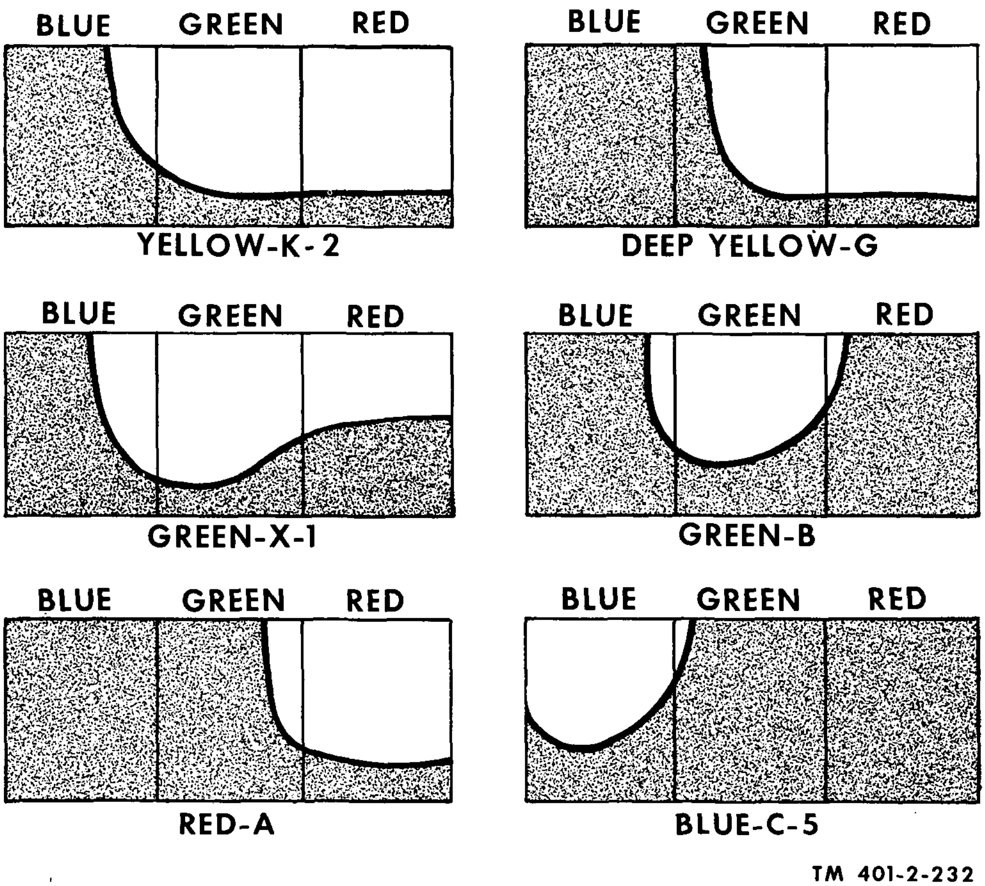

Figure 2-32. Absorption curves.

that the red (A) filter passes almost 80 percent of the red wavelengths (600 to 700 mμ) but almost none of the lower wavelengths. The green (X-1) filter passes 70 percent of the green (520 mμ), 40 percent of the red (650 mμ), and also a little blue.

d. As you can see in figure 2-32, all filters reduce the intensity of the light that reaches the film. The amount of overall light a filter absorbs is indicated by a number called the filter factor.

2-48. Filter Factor States Exposure Increase

a. The *filter factor* tells you how much you have to increase the exposure when you use the filter. The factor depends on the color sensitivity of the film, the color of the illumination, and the density of the filter.

b. The more dense the filter, the higher the filter factor. The more dense the filter, the less light gets through, thus requiring a longer exposure.

c. The less sensitive the film is to the color of the filter, the higher the filter factor. Let's see why. The color of the filter is the color that reaches the film. If the film is not very sensitive to that color, you'll need a very long exposure. An extreme example would be to use a red (A) filter with ortho film. Ortho film does not react to red light and a red (A) filter passes only red light. So when red light reaches the film nothing happens, and the exposure takes forever. Thus, do not use a red (A) filter with ortho film.

d. Although you do not always notice, there is a color difference between daylight and artificial light. Daylight contains more blue, and most electric lights contain more red. Therefore, a blue-absorbing filter has a higher filter factor when used outdoors, and a red-absorbing filter has a higher filter factor when used indoors with artificial light.

e. Table 2-IV shows how the filter factor varies with filter, film, and illumination. A pola-screen has a constant filter factor (2.5) for all film under any light because of its neutral density. According to table 2-IV, what is the filter factor for a blue (C5) filter used with ortho daylight film?

f. According to table 2-IV, the filter factor for a blue (C5) filter used with ortho daylight film is 3. Table 2-IV is general and not specific for each of the many varieties of pan and ortho films; however, *filter factor data on a specific type of film is packaged with the film.*

2-49. Multiply Exposure by Filter Factor

a. The filter factor tells you how much to increase the exposure to compensate for the light the filter absorbs. A filter factor of 2 means you need twice the amount of light. A filter factor of 3 says multiply your basic exposure by 3. (TM 11-401-1 explains how to calculate the basic exposure.)

b. If you reduce the shutter speed by half, you double the amount of light that gets to the film because shutter speed is directly related to exposure. Thus, to correct your basic exposure you can simply multiply the shutter speed by the filter factor. For example, assume a basic shutter speed of 1/100 second and a filter factor of 4. Multiplying 1/100 by 4 gives you 4/100 or a shutter speed of 1/25 second. Note that 1/25 is four times slower than 1/100; thus, four times as much light gets to the film.

c. You can also increase the exposure by using

Table 2-IV. Variation of Filter Factor

The following are general filter factors and may be different for a specific film. Check data packaged with film.

Filter			Filter factor					
			Pan B		Pan C		Ortho	
Type	No.	Color	Daylight	Tungsten	Daylight	Tungsten	Daylight	Tungsten
A	25	Red	8	4	4	2	*	*
B	58	Green	8	8	8	6	8	5
C4	49	Blue	12	25	12	25	7	15
C5	47	Blue	5	10	5	10	3	4
F	29	Deep red	16	8	8	4	*	*
G	15	Deep yellow	3	2	2.5	2	5	3
K1	6	Light yellow	1.5	1.5	1.5	1.5	2	1.5
K2	8	Yellow	2	1.5	2	1.5	2.5	2
X1	11	Light green	3	2	4	3	*	*
X2	13	Green	5	3	6	4	*	*
		Pola-screen	2.5	2.5	2.5	2.5	2.5	2.5

* This filter is not recommended for ortho film.

a wider aperture. Opening one f-stop doubles the exposure. Remember that f-stop numbers get smaller as the aperture gets larger. For example, if the basic exposure f-stop is f/5.6 and the filter factor is 2, you need to double the exposure or open one f-stop to f/4. If the filter factor is 4, you need to double the basic exposure twice or open two f-stops. A basic exposure using an f/16 and a filter factor of 4 requires an opening of f/8. Table 2–V shows the proper f-stop to use for various basic exposures and filter factors.

d. Check how well you understand the use of filter factors by solving the following problems. Use table 2–V to help in your computation.

e. Problems—

(1) To compensate for a filter factor of 3 when the basic exposure is f/16 at 1/150 of a second, you could either change the shutter speed to ________ or set the lens opening at ________.

(2) If your film is 200 ASA, the day is cloudy bright, and the subject is of average brilliance, then the basic exposure would be a shutter speed of ________ and a lens opening of ________. To compensate for a filter factor of 2 you could either change the shutter speed to ________ or change the lens opening to ________.

f. The answers to the above problems are: (1) 1/50, f/9.1 and (2) 1/200, f/8, 1/100, f/5.6.

2–50. Types of Filters

a. There are three types of filters classified by construction: gelatin, cemented, and glass. Dyed gelatin sheets come in a wide range of colors and density and can be cut to any desired shape; however, they are very thin, unstable, and easily damaged. Cemented filters are sheets of gelatin glued between two pieces of clear glass. This gives the filter some strength and stability, but the glue, which must be optically pure, is sensitive to heat. Dyed glass filters, constructed in one piece, are not as sensitive to heat as cemented filters. There are fewer varieties of dyed glass filters than the other types mentioned. Both cemented and dyed glass filters affect the focusing slightly by displacing the focusing plane. However, due to their thinner construction, dyed glass filters affect the focusing to a lesser degree.

b. Dirt, moisture, and fingerprints reduce the usefulness of all filters. So treat filters carefully.

2–51. When and What Filter to Use

Table 2–VI describes the characteristics of various filters, and table 2–VII tells what filter to select for a given situation. After you have studied the tables answer the questions below. Answers are in *c* below.

a. What is the main use of a deep yellow (15G) filter according to table 2–VI?

b. What filter would you use to increase the legibility of orange lettering? See table 2–VII.

c. These are the answers to the questions in *a* and *b* above.

(1) The main use of a deep yellow (15G) filter is for open landscape.

(2) To increase the legibility of orange lettering use a blue (C5) filter.

2–52. Summary of Filters

After you supply the missing words, the following sentences summarize the material covered in

Table 2–V. F-Stops for Filter Factors

1.0 or no filter	1.5	2	2.5	3	Filter factors 4	5	6	8	10	12	14	16	18	20	22	24
2.3	2															
2.8	2.3	2														
3.2	2.8	2.3	2.2	2												
4	3.2	2.8	2.5	2.3	2											
4.5	4	3.2	3	2.8	2.3	2.2	2									
5.6	4.5	4	3.6	3.2	2.8	2.5	2.3	2								
6.3	5.6	4.5	4.3	4	3.2	3	2.8	2.3	2.2	2						
8	6.3	5.6	4.5	4.3	4	3.6	3.2	2.8	2.5	2.3	2.2	2				
9.1	8	6.3	5.9	5.6	4.5	4.3	4	3.2	3	2.8	2.5	2.3	2.2	2		
11.3	9.1	8	7.2	6.3	5.6	5.1	4.5	4	3.6	3.2	3	2.8	2.5	2.3	2.2	2
12.5	11.3	9.1	8.5	8	6.3	5.9	5.6	4.5	4.3	4	3.5	3.2	3	2.8	2.5	2.3
16	12.5	11.3	10.1	9.1	8	7.2	6.3	5.6	5.1	4.5	4.3	4	3.6	3.2	3	2.8
18	16	12.5	11.8	11.3	9.1	8.5	8	6.3	5.9	5.6	5.1	4.5	4.3	4	3.5	3.2
22	18	16	14	12.5	11.3	10.1	9.1	8	7.2	6.3	5.9	5.6	5.1	4.5	4.3	4
25	22	18	17	16	12.5	11.8	11.3	9.1	8.5	8	7.2	6.3	5.9	5.6	5.1	4.5
32	25	22	20	18	16	14	12.5	11.3	10.1	9.1	8.5	8	7.2	6.3	5.9	5.6

Table 2-VI. Filter Characteristics

Type of filter	Filter factor	Performance characteristics
Aero 1, K1, light yellow	1.5	Slight color correction for all types of panchromatic films. Produces slight contrast. Penetrates light haze. Improves facial details with little added exposure.
Aero 2, K2, K3, yellow	2.0	Normal color correction for all types of panchromatic films. Produces medium contrast. Darkens blue sky. Brings out clouds. Greater haze penetration than Aero 1. The most popular filter for general outdoor photography. Absorbs ultraviolet, violet, and some blue.
12 minus blue yellow	2.0	Slightly stronger effect than Aero 2. Useful in eliminating haze in air motion picture photography. Color correction between Aero 2 and 15G.
15G deep yellow	2.0	Full color correction for all types of panchromatic film. Produces greater contrast than 12 and Aero 2. Used more for open landscape. Darkens blue sky, bringing out clouds. Penetrates distant haze. For use with long focal length lenses. Lightens all yellows, reds, and oranges.
No. 21 orange	2.0	Slight overcorrection for all types of panchromatic film. Produces more contrast than G filter. Strong cloud effects. Good for mountain and air photography. Penetrates distant haze with long focal length lenses.
23A orange red	4.0	Medium overcorrection for all types of panchromatic film. Darkens blue sky and water for light night effect in sunlight. Produces more contrast than No. 21 filter. Darkens greens slightly. Lightens all yellow, orange, and red colors.
25A red	8.0	Considerable overcorrection on panchromatic film. Action same as 23A but more pronounced. Produces very strong contrast. Penetrates aerial haze. Creates dramatic and spectacular night effects. Standard tricolor red filter for three-color separation negatives. Normally used with infrared films.
29F deep red	16.0	Extereme overcorrection and contrast. Full night effects in strong sunlight. Turns blue sky and water to strong black. Turns all yellow, orange, and red colors into white. Used with infrared films. This filter is also useful with C4 and N-67 in making separation negatives from original color transparencies.
35D magenta	....	Moderately stable contrast filter. Transmits both red and blue. Darkens green and orange and lightens violet and red. Used singly or in pairs for scientific research and for photomicrography.
47 C5 blue	6.0	Generally used with orthochromatic films to increase blue contrast. Makes blue sky lighter and any emulsion colorblind. Also used as tricolor blue for color separation negatives from color transparencies.
49 C4 dark blue	14.0	Experimental tricolor filter. Generally used as a viewing filter for arc and daylight illumination. Increases blue contrast on all orthochromatic films. Also used for separation negatives from color transparencies.
X1 light green	4.0	Slight softening effect and good correction for all types of panchromatic film. Can also be used with orthochromatic films. Renders green and yellow slightly lighter, red and blue slightly darker.
X2 green	6.0	Medium softening effect and good correction with all types of panchromatic film. Slightly stronger green contrast than X1. Darkens reds and blues.
56 B3 green	4.0	Strong softening effect with all types of panchromatic film. Produces green and yellow contrast. Same action as X1 and X2 but with much stronger effect. Used with 23A for soft night effect in sunlight.
48 B2 dark green	12.0	Slightly stronger than 56 B3. Used for greater contrast. Records green and yellow very light, other colors dark. Also used as tricolor green for three-color separation work.
3 N5 yellow green	4.0	Combination of Aero 1 and 50% ND. Slight color correction. General use, open landscape, street, desert, and snow scenes.
5 N5 yellow green	6.0	Combination of Aero 2 and 50% ND. Normal color correction. Used for snow scenes and strong contrast. Gives pleasing value to open water photographs.
70 deep red	32.0	Extreme overcorrection and extreme contrast in all blue and green colors. Used generally for haze cutting in air photography and heavy night effects in strong sunlight. Also used with infrared film.
72 brown red	80.0	Extreme overcorrection and contrast in all blue values. Turns blue sky and water into jet black. Can be used for long distance haze cutting in air photography and for extreme night effects in sunlight.
88A very deep red	11.0	Cuts out all visible colors but transmits infrared rays. Can be used only with infrared films. Used in air photography requiring very strong sunlight. Cannot be used with any other type of film.

Table 2–VI. Filter Characteristics—Continued

Type of filter	Filter factor	Performance characteristics
90 deep yellow	....	A monochromatic viewing filter showing relative color values and their photographic densities. Designed primarily for visual use to reduce color differences to a monotone. Also used as a guide to determine relative density of tungsten illumination on subject.
25% ND neutral	1.8	Slight contrast neutralizer. Softens light glare and contrast and functions as light exposure compensator. Has no corrective color value.
50% ND neutral	3.0	Medium contrast neutralizer. Used for medium softening of glare and contrast. Medium exposure compensator. May be used with all types of film and with any filter.
100% ND neutral	10.0	Extreme contrast neutralizer. Same action as 50% ND but with greater degree of softening effect.
200% ND neutral	20.0	Extreme contrast neutralizer. Same action as 100% ND but with greater degree of softening effect. Used with very strong sunlight.
Pola-screen	2.5	For controlling strong glare and brightness of sky and water and harshly lit and contrasty subjects. Dissolves reflections through glass and water without changing the color density. Darkens blue sky to about the same extent as an A filter. May be used with any filter. The maximum results are obtained with the sun's rays at 90-degree angle to the camera. Two pola-screens together form a variable neutral density filter with a range up to 32% transmission.
47B blue violet	5.0	Used for three-color separation.
N–61 green	10.0	Used for three-color separation.

Table 2–VII. Filter Selection

Subject	Desired effect	Filter selection
Architecture, light colored buildings against blue sky.	Separate building and sky	K2
	Greater building-sky contrast	G
	Dark sky	A
Red brick	Show texture	G
Furniture (reddish woods)	Show grain	A
Leather, wallpaper	Natural condition	Correction filter as indicated below. *Film* — *Daylight* — *Tungsten* Ortho — K2 — Pan B — K2 — X1 Pan C — X1 — X2
Colored objects	Increase contrast	Contrast filter as indicated below. (Filters listed in order of decreasing effect.) *Color of subject* — *To lighten use—* — *To darken use—* Red — A, F, G — C5, B Green — B, X1, X2 — C5, A Blue — C5 — F, A, G, B Cyan — C5, B — F, A Magenta — F, A — B Purple — C5 — B Yellow — K2, G, A — C5 Orange — G, A — C5
Lettering	Increase legibility	Contrast filter to darken (see above).
Mountain views, ice, snow, and water.	Reduce haze	Haze filter (any blue-absorbing). The following are listed in order of increasing effectiveness. K2, G, X1, A
Glass, bright sky, water, and wet pavement.	Reduce reflection	Pola-screen

this section on filters. Completed statements are in paragraph 2-62.

a. Color filters absorb some colors of light and -------- other colors.

b. Black and white film (is, is not) sensitive to color.

c. When a filter absorbs a color, that area on the print is --------.

d. A filter passes its -------- color.

e. There are three primary colors: --------, -------- and --------.

f. Combining two primary colors produces one of the three secondary colors: --------, -------- and --------.

g. Two complementary colors combine to form --------.

h. Correction filters adjust the color sensitivity of the film to that of the --------.

i. Contrast filters are used to ------------ or ------------a particular color.

j. Use the same color to lighten and the ------------ to darken.

k. Haze filters ------------ atmospheric haze but not dust or smoke.

l. Polarized light vibrates in ---------- direction.

m. Pola-screen filter -------- light, thus controlling sky brightness and ------------.

n. Absorption curves show the effect of ---------- over the complete color range.

o. The filter factor tells you how much to ---------- the basic exposure.

p. Either multiply the shutter speed by the filter ---------- or open the aperture an equivalent amount to compensate for the loss of ---------- when using a filter.

q. Handle filters carefully; they are fragile, sensitive to ----------, and are affected by ----------. Their efficiency is reduced by fingerprints.

Section VI. FILM

2-53. Film Controls Picture Quality

To produce high quality pictures, you must select the proper film for the job. In selecting the proper film consider color sensitivity, film speed, and contrast. We will discuss only black and white film in this section.

2-54. Film Type and Color Sensitivity

a. The many different varieties of film can be reduced to five basic types by their color sensitivity. The types are nonchromatic, orthochromatic, panchromatic B, panchromatic C, and infrared. The color sensitivity of each of these types and the human eye is shown in figure 2-33.

b. Nonchromatic (blue-sensitive) *film* records only ultraviolet and blue light. All film is sensitive to these colors. Nonchromatic film generally has high contrast and is used mainly for copying black and white originals or other work where color is unimportant.

c. Orthochromatic film records green, blue, and ultraviolet light but not red. Thus, reds appear dark on the prints.

d. Panchromatic B film records some red as well as green, blue, and ultraviolet light. It's fairly close to the eye in color sensitivity. The natural color rendition makes it useful in close portraits.

e. Panchromatic C film records more red than pan B, making the reds print a lighter gray. The greater contrast between clouds and sky makes pan C useful for scenery.

f. Infrared film is sensitive to ultraviolet and blue light as are all films. It's also sensitive to the wavelengths longer than those visible to the eye, called infrared. Since infrared film is sensitive to light beyond the visible light, the film is used to see what cannot be seen by the human eye. *For example,* artificial trees used as camouflage appear darker than live trees when photographed with infrared film.

2-55. Selecting Film Speed

a. Film speed, given by ASA rating, tells how much light you need. Normal film speed is about ASA 100. When the lens opening is f/16, your shutter speed corresponds to the ASA rating as follows:

ASA	*Shutter speed*
100	1/100 second
50	1/50 second
25	1/25 second

b. Fast films have ASA ratings well above 100, perhaps even up into the thousands. The fast films allow you to use very fast shutter speeds to stop the action and photograph moving objects. Also, since less light is required for fast films, a slow shutter speed used with the fast film permits photographing under poor lighting conditions.

c. Slow films, under ASA 100, are used for copying. And because they usually have a finer grain, slow films are used when there will be enlargements.

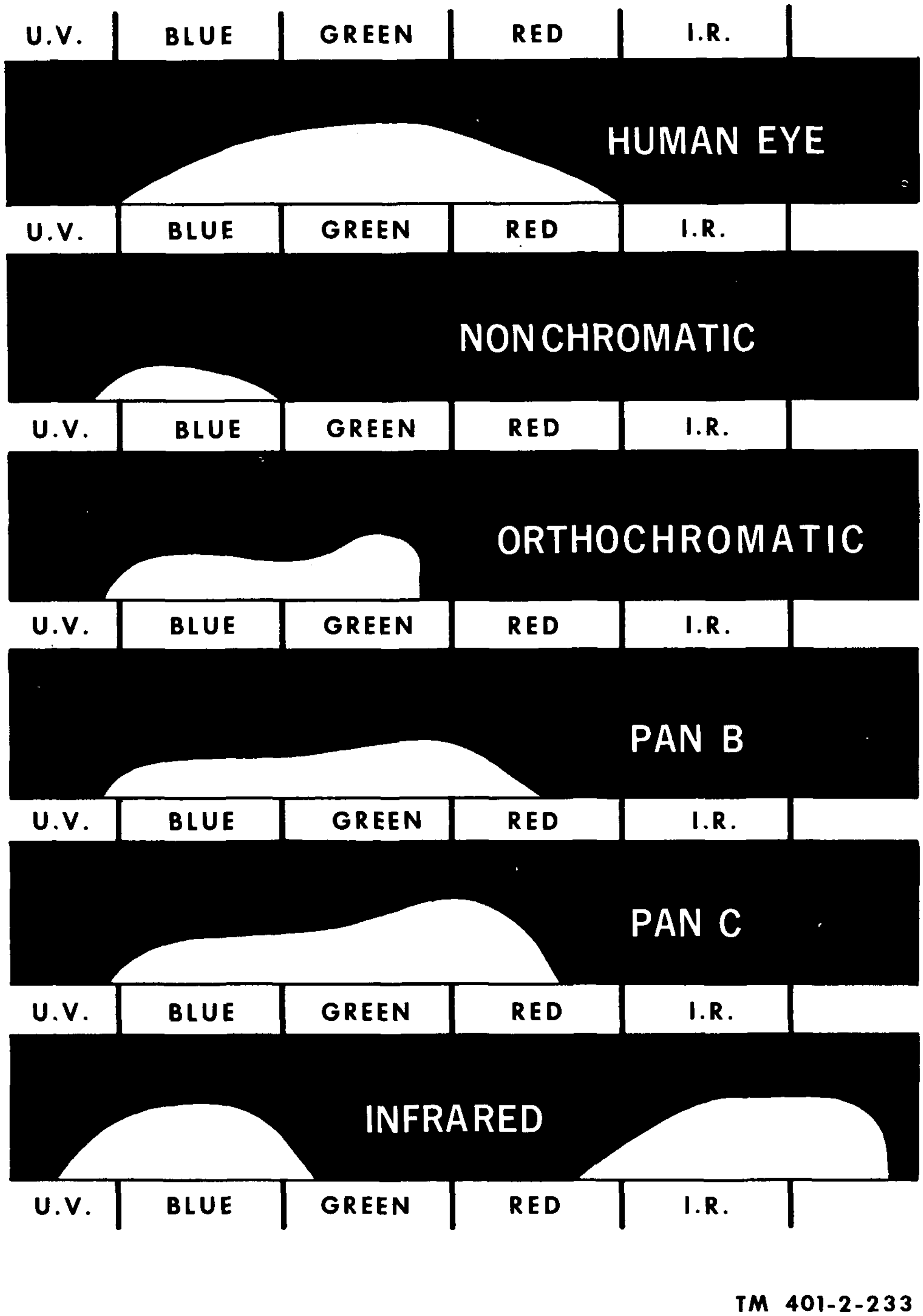

Figure 2–33. Film color sensitivity.

2–56. Contrast is the Range of Tones

a. Normal contrast film is most commonly used because it reproduces white, black, and all shades of gray.

b. When the scene has a constant tone such as bright objects with a bright background on a bright day with little difference in color, or a dull, dark scene, then use a high contrast film to make the whites whiter and the blacks blacker. Also use high contrast film for copying printed pages or graphs where there are no grays, only black and white.

c. Low contrast film shows mostly middle gray and lacks black and white. Use this film to reduce sharpness in high contrast scenes such as a dark subject against a very bright background.

2–57. Film Selection

a. Table 2–VIII summarizes this section on film and gives a general procedure for selecting film. What type of film is recommended in table 2-VIII for photographing a wheatfield with mountains in the background? The answer is given in *c* below.

b. Table 2-IX gives the characteristics of various films. What is the daylight ASA rating and use of Ansco SSS ortho film? The answers are given in *c* below.

c. The film recommended for scenery or landscapes such as a wheatfield is *pan C.* Ansco SSS ortho film is a high speed film (250 ASA for daylight) used for *general photography and portraiture.*

Table 2-VIII. Film Selection

Condition	Film
Action, moving object	Fast (high ASA)
Copying, black and white	High contrast, nonchromatic
Copying, with gray tones	Medium contrast
Enlargements	Slow (low ASA)
Open, bright, sharp contrast	Low contrast
People, groups	Ortho
People, portraits	Pan B
Scenery, landscapes	Pan C
Scientific, technical, and tactical detection of heat and light.	Infrared
Shade, dark, dull contrast	High contrast

Section VII. REVIEW MATERIAL

2-58. Final Summary

a. AR 108-5, your assignment, your plan of operation, your personal conduct, and the requirement of keeping records all control picture quality.

b. Your selection of film controls picture quality. The other technical controls of picture quality are summarized in paragraphs 2-59 through 2-62.

2-59. Answers to Review Questions on Composition

The following statements answer the questions in paragraph 2-18 and summarize the rules of composition:

a. The rules of good composition *are not* hard-and-fast laws and may be altered to fit the situation.

b. Each picture should present *only one* idea.

c. Each picture should contain *just* enough detail to serve the purpose of the picture.

d. There should be *one* center of interest.

e. The center of interest should be *one-third* from one side and *one-third* from either the top or bottom of the picture.

f. The photograph *should* be balanced.

g. Objects of equal size placed symmetrically produce a *balanced* photograph.

h. Objects of unequal size can balance a picture if the smaller object is placed *farther* from the point of balance than the larger object.

i. The picture area *should not* be divided into two equal areas.

j. The horizon should be *one-third* from either the top or bottom of the picture and not in the *middle.*

k. The picture should have direction lines that lead the eye to the *center of interest.*

l. Lines give character to the photograph and support its purpose. Horizontal lines indicate *peace and quiet,* vertical lines indicate *strength and power,* slanted lines indicate *force and action,* and curved lines indicate *grace and charm.*

m. Tonal separation is the difference in the *shades of gray.*

n. The picture should have *depth* to give realness.

o. The foreground should support the subject, set the *scene,* and aid in the *illusion of depth.*

p. The background should not interfere with the subject being presented and should not have *fine detail.*

q. A border of picture area should *frame* the scene.

r. The camera is normally held at *eye* level, but it should view the subject at an angle—looking right or left for depth, looking down to *shorten* the subject or looking up for *height.*

2-60. Answers to Summary of Perspective

The following statements answer the questions in paragraph 2-26 and provide a summary of perspective.

a. The illusion of depth in a photograph is created by image size, image placement, and *perspective.*

b. Distant objects appear *small.*

c. Objects near the horizon appear *distant.*

d. Images partly hidden by other images appear *distant.*

e. Parallel lines that are parallel to the film produce *parallel lines* on the print.

f. Parallel lines that are not parallel to the film plane appear to *converge* on a distant point called the *vanishing* point.

g. Tilting the camera up or down produces the

Table 2-IX. Characteristics of Black and White Film

Film name and manufacturer	Type	Roll film—RF, filmpack—FP, cut-sheet film—CF, 35-mm film—35	Characteristics	Speed rating (ASA) Day	Tung.
Ansco All Weather Pan	Pan	RF, FP	Practical high speed film for general photography.	125	80
Ansco Commercial Ortho	Ortho	CF	Medium speed film for copying blueprints and similar material where a blue filter will improve rendition.	50	25
Ansco Commercial Pan	Pan	CF	Medium speed film for copying colored objects and general commercial work with filters.	50	12
Ansco Isopan	Pan	CF	Fine grain, high speed film for large illustrations, murals, and three-color separation negatives.	100	60
Ansco Plenachrome	Ortho	RF	High speed film, wide latitude, suitable for wide range of outdoor subjects.	100	50
Ansco SSS Ortho	Ortho	CF	High speed film for general photography and portraiture.	250	125
Ansco SSS Pan	Pan	CF	Extremely high speed film for portrait, news, and action photography; also flash and artificial light exposure.	400	320
Ansco Super	Pan	RF, FP, CF, 35	Extremely high speed film for indoor or outdoor photography under poor light conditions or when fast shutter speeds are essential.	500	400
Ansco Super Pan Portrait	Pan	CF	High speed film for portraiture and other indoor or outdoor subjects.	100	80
Ansco Super Pan Press	Pan	RF, FP, CF	Extremely fast film for indoor or outdoor photography with poor light conditions or when fast shutter speeds are necessary.	200	160
Ansco Super Plenachrome Press.	Ortho	CF	High speed film for action and general photography.	200	80
Ansco Super Sensitive Plenachrome.	Ortho	CF	Suitable for portraiture and general indoor and outdoor photography.		
Ansco Supreme	Pan	35, RF, FP	High speed, fine grain film for day or night photography, indoor or out.	100	60
Ansco Versapan	Pan	CF	High speed, fine grain film for day or night photography.	100	80
Dupont Arrow Pan	Pan	CF	Extremely high speed film with antihalation backing for press and flash photography or where high shutter speeds must be used.	320	320
Dupont Commercial	Ortho	CF	Slow film for copying blueprints and similar material.	24	6
Dupont Fine Grain Pan	Pan	CF	Slow film for maximum enlargements	32	20
Dupont High Speed Pan	Pan	CF	Extremely high speed film for a great variety of photographic work.	320	320
Dupont Superior Press	Pan	CF	Extremely high speed film for indoor and outdoor photography under poor light conditions or when high shutter speeds required.	400	400
Dupont XF Ortho	Ortho	CF	Extra fast film with nonhalation backing for portraiture and news photography.	64	32
Dupont XF Pan	Pan	CF	Fast film with antihalation backing for portraiture and general interior and exterior work.	125	125
Kodak Commercial Ortho	Ortho	CF	Moderate speed, fine grain film for copying certain types of continuous-tone color objects.	80	25
Kodak Contrast Process Ortho.	Ortho	CF	Medium speed, high contrast film for copying line originals in monochrome as well as certain types of colored originals where red sensitivity is not necessary.	50	16
Kodak Contrast Process Pan.	Pan	CF	Slow, high contrast film, sensitive to light of all colors. Used for copying originals drawn or printed in colored inks.	20	16

Table 2-IX. Characteristics of Black and White Film—Continued

Film name and manufacturer	Type	Roll film—RF, filmpack—FP, cut-sheet film—CF, 35-mm film—35	Characteristics	Speed rating (ASA)	
				Day	Tung.
Kodak Infrared (with No. 25 Wratten A filter).	Infrared	35	Sensitive to infrared radiation		20
Kodak Infrared (with No. 25 Wratten A filter).	Infrared	RF, CF	Sensitive to infrared radiation in addition to the normal blue violet sensitivity. Used for landscapes, medical, documentary, and other technical and scientific fields of photography.	10	
Kodak Panatomic X	Pan	35, RF	Extremely fine grain film for general use	40	40
Kodak Panatomic X	Pan	CF	Extremely fine grain film for general use	64	64
Kodak Plus X Pan	Pan	35, RF, FP	Fine grain, wide latitude film for general use	160	160
Kodak Plus X Portrait	Pan	35	Fast, fine grain portrait film	160	160
Kodak Portait Pan	Pan	CF	Standard film for all types of portraiture	125	125
Kodak Royal Ortho	Ortho	CF	Extremely high speed film for press and portrait photography.	400	250
Kodak Royal Pan	Pan	CF	Extremely high speed film for a great variety of photographic work. Good tonal rendition.	400	400
Kodak Royal X	Pan	RF, FP, CF	Extremely high speed film for indoor and outdoor photography under poor light conditions or when very high shutter speeds are essential.	1,250	1,250
Kodak Super Ortho Press	Ortho	FP, CF	High speed film for press work where panchromatic film is not necessary or desirable.	200	100
Kodak Super Panchro Press Type B.	Pan	CF	High speed, fine grain film for press work with flash and other artificial illumination.	250	250
Kodak Super Speed Ortho Portrait.	Ortho	CF	Moderately fast in daylight and fair speed in artificial light. Designed for portraiture.	125	64
Kodak Super XX Pan	Pan	CF	Extremely high speed film for indoor and out-outdoor use under adverse light conditions. Especially useful with artificial light and flash.	200	200
Kodak Tri-X Pan	Pan	35, RF, CF, FP	Extremely fast, long tonal scale, quality and moderate contrast film. Ideal for color separation negatives.	400	400
Kodak Verichrome Pan	Pan	RF, FP	High speed film for general outdoor use. Also suitable for night photography with flash.	125	125

unpleasant perspective that causes *vertical* lines to converge.

h. When the camera is too close to the subject the perspective is exaggerated and the picture *distorted.*

i. Increasing the lens-to-subject distance improves the perspective but *reduces* the image *size.*

j. Increasing the focal length does not actually alter the perspective, but because of increased *image size* and decreased *angle of view* there is an apparent change in perspective.

k. The normal lens has a focal length equal to the *diagonal* of the film and an angle of view of about *50* degrees.

l. A wide-angle (short focal length) lens has a focal length *shorter* than the diagonal of the film, an angle of view *greater* than 55 degrees, and is used mainly in cramped quarters.

m. A telephoto (long focal length) lens has a focal length *longer* than the diagonal of the film, an angle of view less than *45* degrees, and is used to bring out detail of distant objects.

n. A print should be viewed from a distance equal to the *focal length* times the number of times it was *enlarged.*

2-61. Answers to Review of Swing Adjustments

The following statements answer the questions in paragraph 2-35 and provide a summary of swing adjustments:

a. Swinging the back is used to control *perspective.*

b. Swinging the back so that the film is more parallel with the front of the subject makes the print look more like a *front* view.

c. Tilting the back up allows you to photograph taller objects but distorts the *perspective* by making the sides *converge.*

d. A better method to gain height is to keep the back *vertical* and tilt the camera up.

e. Raising the front is used to *position* the image on the film.

f. Swinging the front is used to control the *depth of field.*

g. Tilting the front causes the plane of focus to the tilt in the *same* direction but with a *larger* amount of tilt.

h. The amount of swing possible is limited by the *angle of field.*

2-62. Answers to Summary of Filters

The following statements answer the question in paragraph 2-52 and provide a summary of filters:

a. Color filters absorb some colors of light and *pass* other colors.

b. Black and white film *is* sensitive to color.

c. When a filter absorbs a color, that area on the print is *darker.*

d. A filter passes its *own* color.

e. There are three primary colors: *red, green,* and *blue.*

f. Combining two primary colors produces one of the three secondary colors: *yellow, cyan,* and *magenta.*

g. Two complementary colors combine to form *white.*

h. Correction filters adjust the color sensitivity of the film to that of the *eye.*

i. Contrast filters are used to *lighten* or *darken* a particular color.

j. Use the same color to lighten and the *complement* to darken.

k. Haze filters *penetrate* atmospheric haze but not dust or smoke.

l. Polarized light vibrates in *one* direction.

m. Pola-screen filter *polarized* light, thus controlling sky brightness and *reflections.*

n. Absorption curves show the effect of *filters* over the complete color range.

o. The filter factor tells you how much to *multiply* the basic exposure.

p. Either multiply the shutter speed by the filter factor or open the aperture an equivalent amount to compensate for the loss of *light* when using a filter.

q. Handle filters carefully; they are fragile, sensitive to *heat,* and are affected by *moisture.* Their efficiency is reduced by fingerprints.

CHAPTER 3

PORTRAIT PHOTOGRAPHY

Section I. PORTRAIT TYPES

3–1. Introduction

a. An identification photograph should look as natural as the person so there will be no question that the person in the picture and the bearer are the same. Since you may have had an uncomplimentary identification photograph some time, you can appreciate a person's wish for a good likeness. Thus, you will want to be especially careful to produce the best possible identification photograph of your subject.

b. Other types of portraits should do more than identify the person—they should show the person to best advantage.

c. This chapter will describe the different types of portraits and tell you how to make a good portrait. It will explain the types of cameras, lenses, and backgrounds; how to use lights; and how to pose your subject.

3–2. Types of Portraits

a. There are three types of portraits: *identification, formal personnel,* and *informal personnel* (fig 3–1). An identification portrait shows a person as he ordinarily looks; a formal personnel portrait shows a person to his best advantage; and an informal personnel portrait shows a person as he appears in his natural environment.

b. Your assignment will tell you directly or indirectly which types of portrait to take. *For example,* the assignment may say to take a picture of Sergeant Jack Jones for a badge, or to take an identification portrait of the sergeant. In either case, you know you must take an identification portrait.

c. Although you usually do not choose the type of portrait, if you can recognize what type is required you'll then know what procedure to use for taking the picture. In general, all portraits are similar, and the procedures for making them are the same; but as you learn more about portrait producing you'll find there are differences in the different types of portraits.

3–3. Identification Portrait—The Man as He Is

a. Identification portraits are used for badges, ID cards, gate passes, and formal records; in other words, for security and legal reasons. The purpose of the photograph is so others who are unfamiliar with a person can recognize that person on sight. Thus, an identification portrait must show the person as he ordinarily looks.

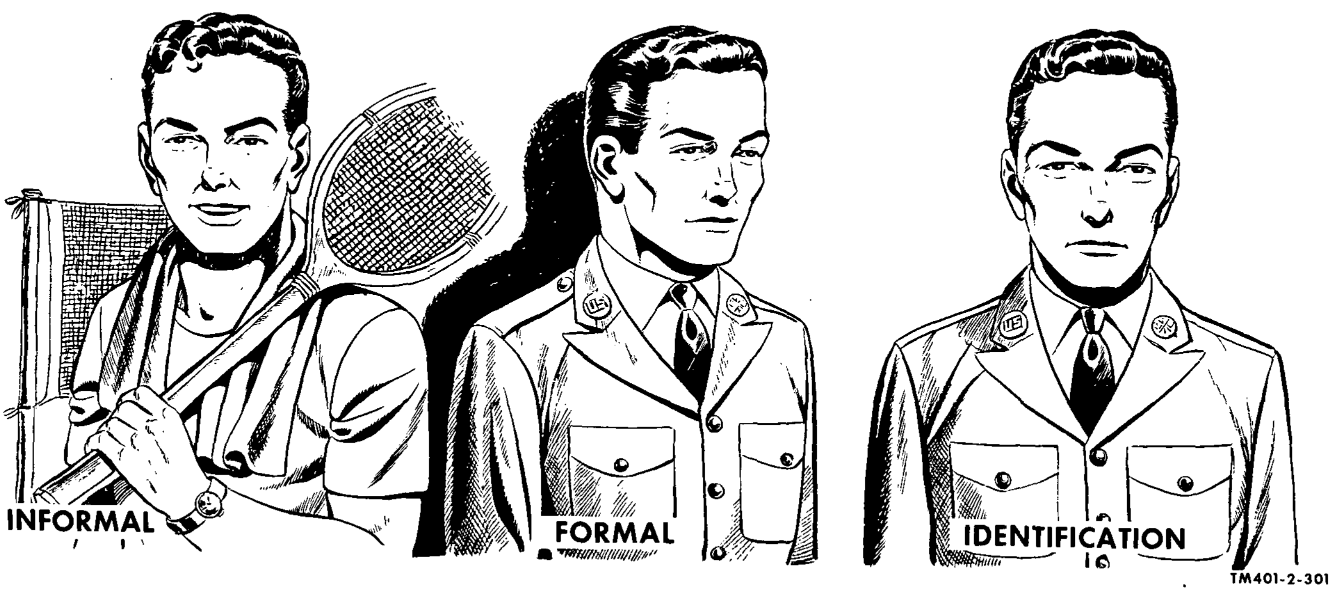

Figure 3–1. Types of portraits.

b. We are accustomed to recognizing people by their faces, because their clothes are often changed or their uniforms may look like everyone else's uniform. Therefore, identification portraits are usually either fullface or profile photographs. They should clearly show all the person's facial detail, and the lighting should be low with no distinct shadows so that no specific characteristic stands out.

3–4. Formal Personnel Portrait—The Person at His Best

a. Some of the uses of formal *personnel portraits* are for records, formal display, and news release identification purposes. For example, this is the type of portrait displayed on bulletin boards or elsewhere to recognize accomplishments such as "soldier of the month." These photographs are also distributed to identify those in command. It is obvious from their uses that formal personnel portraits should show the person at his best.

b. When taking formal personnel portraits, you should pose the subject in a studio against a neutral gray background. The subject should wear class A military dress with full military decorations. Any object appearing in the portrait with the subject must be subordinate to the subject in tone, placement, or size.

3–5. Informal Personnel Portrait—The Person in His Environment

a. Informal personnel portraits are used for display and promotion in similar but more informal and unofficial circumstances than formal personnel portraits. When you want to indicate the subject's position, job, agency, or a particular event, then take an informal personnel portrait.

b. Show the subject of an informal personnel portrait in his natural environment, but do not have him engaged in any activity. The environment serves only as a background to connect the subject with some organization or event. The subject should be dressed properly but not necessarily in a class A uniform.

3–6. How Much of the Subject Should You Show?

a. You determine just how much of the subject to show in the picture by several factors we will discuss later. Generally speaking, there are three standards: head and shoulders, three-quarter length, and full length. These are not meant to be exact measurements. *For example,* a head and shoulder photograph could show most of the subject's chest or none of it.

b. Identification and formal personnel portraits usually show only head and shoulders. This is because we recognize people by their faces and because it is difficult to make a full length picture look pleasing without any detail in the background.

c. Informal personnel portraits often are three-quarter or full length photographs because it's easier to fit the proper background into photographs showing more of the subject.

d. After you have determined the type of portrait your next step is to select the camera.

Section II. CAMERAS FOR PORTRAITS

3–7. What Camera to Use for a Portrait

a. Select a camera that will produce a negative 4 x 5 inches or larger. This is because large negatives are easier to work with if they need retouching and do not need to be enlarged as much as smaller negatives. The more a photograph is enlarged the greater the loss of its sharpness.

b. A camera that produces a smaller negative is all right for ID cards, gate passes, and some other identification portraits that do not need enlarging or retouching.

3–8. Cameras for Identification Portraits

a. Identification Set AN/TFQ–1B.

(1) This is a complete identification set including camera, stand, positioning bar, background, lights, and processing equipment (fig. 3–2).

(2) The camera of the AN/TFQ–1B uses 100 feet of perforated 35-mm motion picture film (usually panchromatic) wound on a number 10 Eyemo reel. You may use a shorter length of film if it is wound on a spool that fits the camera and loaded into the magazine in the darkroom. The positioning bar shows you where to place the subject so he will appear properly in the picture. The background curtain has two usable sides, one plain and one with a height scale. Two lamps of unequal intensity, 300 and 500 watts, are used to produce unbalanced lighting; they are mounted on the camera stand. If you use the set near a window, an open door, or a skylight, you must take into account the addition of sunlight in your lighting procedures. Film processing follows standard laboratory procedures.

b. Still Picture Camera Set KS–19A(1).

(1) This is a complete identification set using diffusion transfer (polaroid) film (fig. 3–3). The

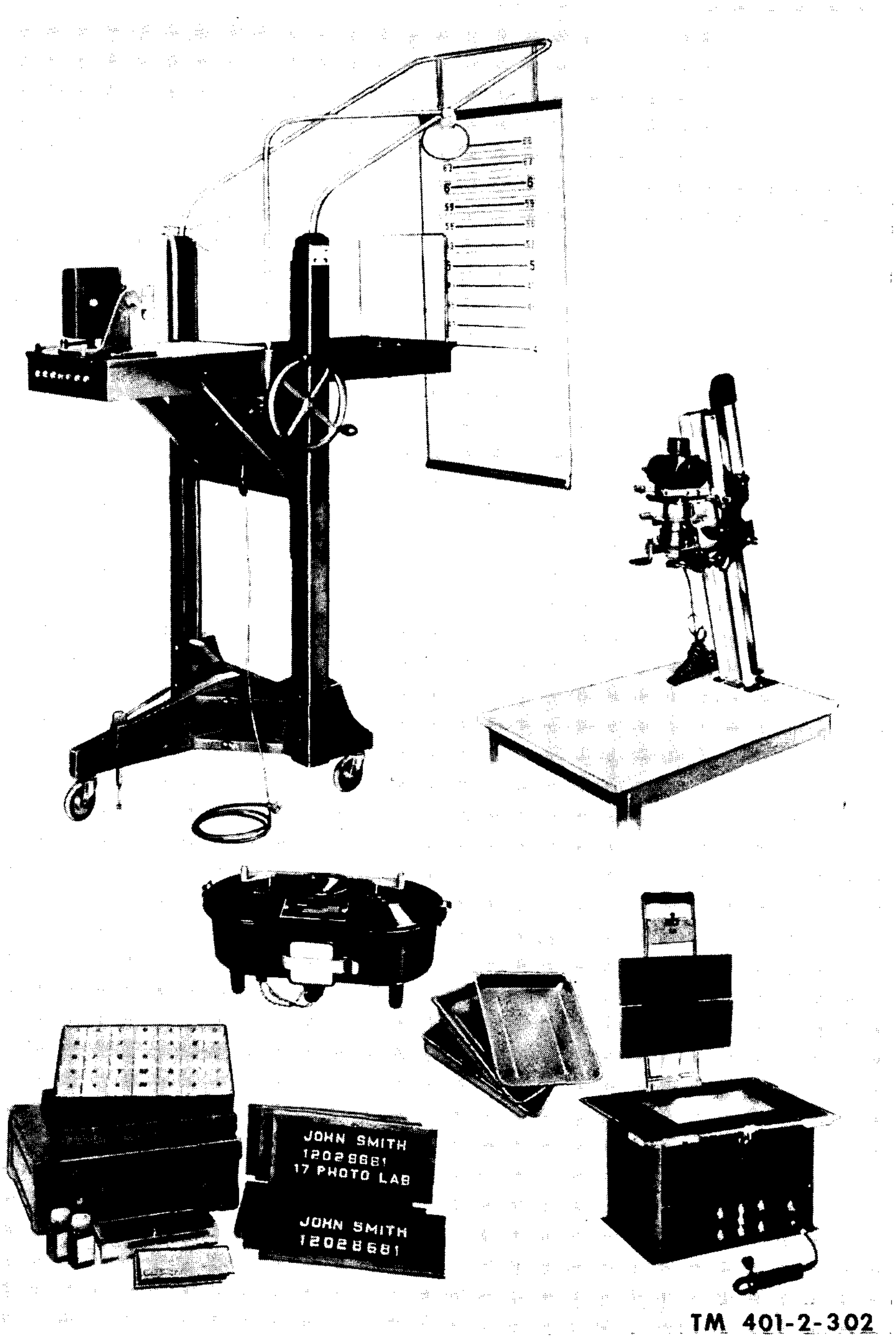

Figure 3-2. AN/TFQ-1B.

advantages of this set are its speed and ease of operation. It operates so simply that anyone with little or no photographic knowledge can use the set with satisfactory results.

(2) In the diffusion transfer process you can remove a black and white print from the camera 10 seconds after exposure. A color print takes 1 minute. You place the film roll, consisting of negative material, print paper, and pods of developer (one pod for each exposure), in the camera as a unit. As you advance the film, the film and print paper come together between two rollers, the pod breaks, and the developer (a jellylike material) spreads over the film. The process is quick, simple, and efficient (ch. 10).

(3) By means of a shift lever and stereoscopic attachment, the KS-19A(1) can produce four identical images, four different images, or a stereograph on the standard 3¼- x 4¼-inch film. The small print size, about a 10X reduction of the sub-

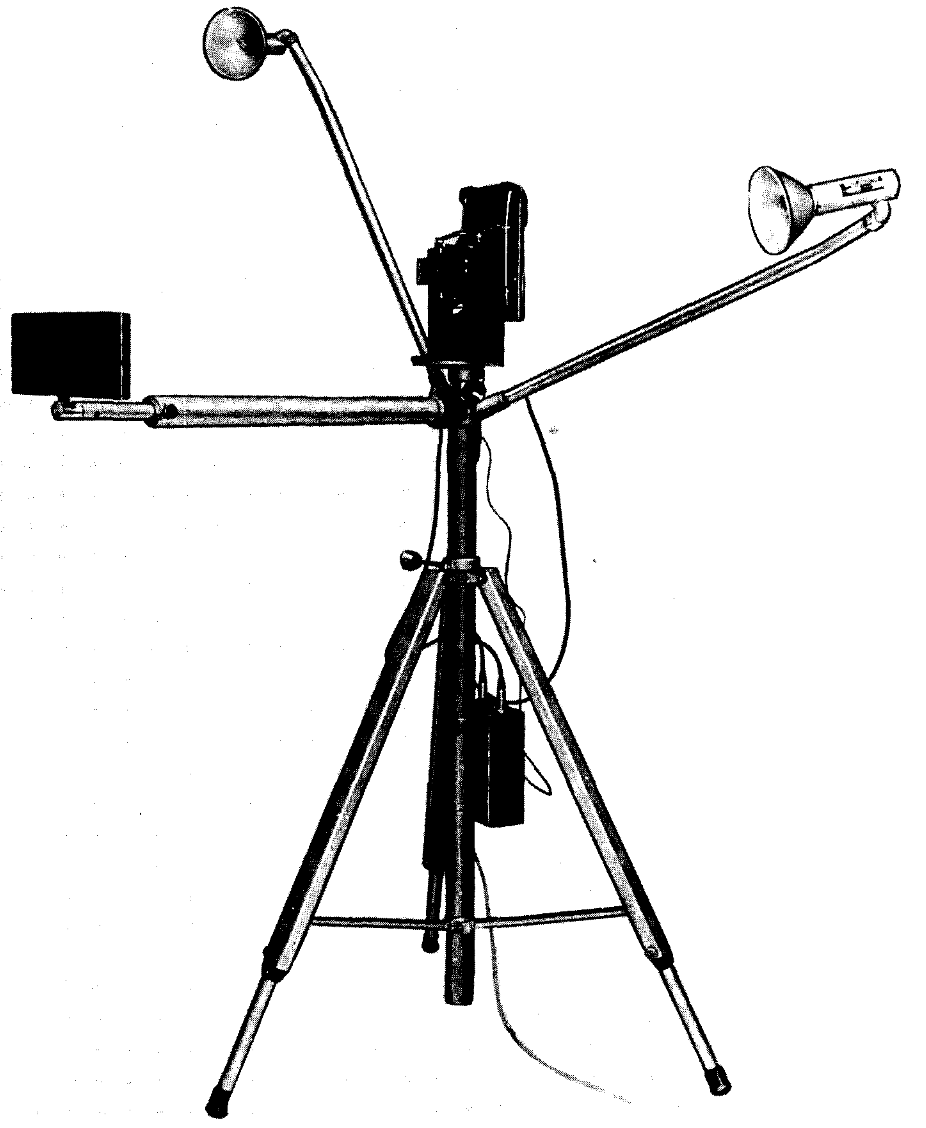
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Figure 3–3. KS–19A(1).

ject, is acceptable for passes or badges worn or carried in pockets.

3–9. Cameras for Informal Personnel Portraits

You may use the cameras recommended below for informal personnel portraits and for formal personnel portraits as well.

a. Still Picture Camera Set KS–17A, is a view camera that uses 4- x 5-inch film and doubles as a portable studio camera (fig. 3–4). This camera is recommended for informal personnel portraits because you can easily take it to the subject and the proper background, and because it uses a large size film.

b. Still Picture Camera KE–12(2), a general purpose camera, is also used for informal personnel portraits (fig. 3–5). The camera's film size, 4- x 5-inch, is not too small and is more than compensated for because the camera is portable and operates rapidly.

3–10. Which Lens to Use for a Portrait

a. Now that you have selected the camera, your next step is to decide which lens will do the job best. Long focal length lenses are better for portraits because they give a more pleasing perspective, a larger image size, and more freedom with lights. Because of the close camera viewpoint, photographs made with short focal length lenses *appear* to distort perspective, making those parts

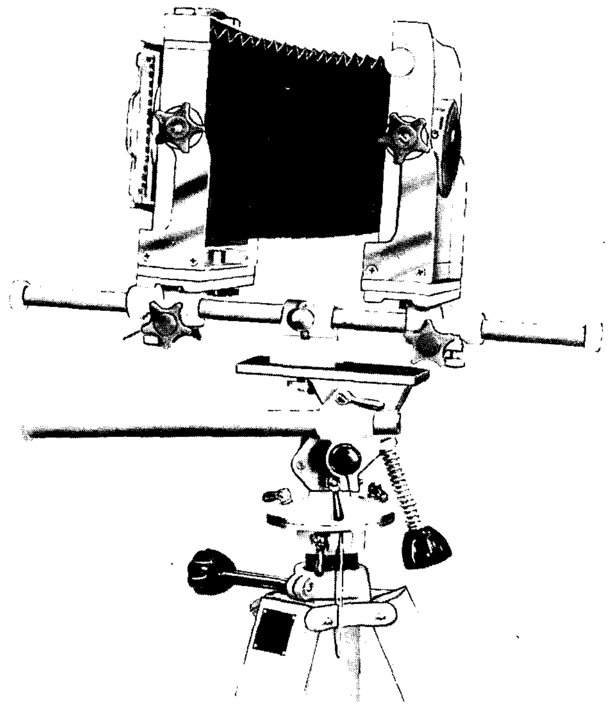

Figure 3-4. KS-17A.

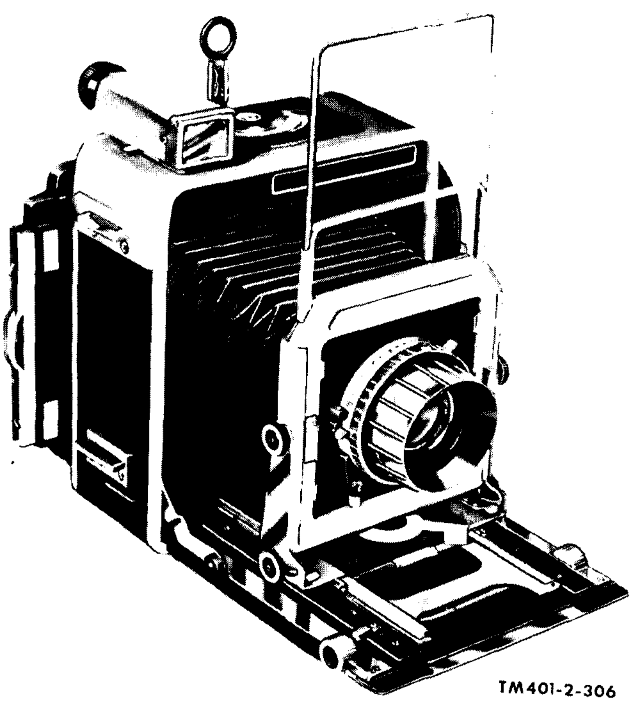

Figure 3-5. KE-12(2).

of the body nearest the camera (such as the nose or the shoulder) look much larger than they should. When you use a normal or short focal length lens, you can improve the perspective by having a greater distance between the subject and the camera. The increased subject-to-camera distance relaxes the subject as well as improves perspective, but it also reduces the image size. You can increase the image size by using a longer focal length. Thus, long focal length lenses are recommended for portraits.

b. If you must use a short focal length because of cramped quarters or another reason, try to keep as much of the subject as possible in the same vertical plane. Keep the subject's hands close to his body or below his head because if his hands are out in front they will be nearer the camera and will appear excessively large on the print. With a short focal length, use camera swings and as much distance as possible for the best perspective.

c. If you're taking a head and shoulders portrait, the focal length of the lens should be equal to or more than the sum of the short and long dimensions of the film format.

d. For a three-quarter or full length portrait, the lens focal length should be equal to or greater than the film diagonal, but less than three film diagonals. For examples see table 3-I.

Table 3-I. Focal Lengths for Portraits

Film		Minimum focal length		Maximum focal length
Dimensions (inches)	Diagonal	Head and shoulders	Three-quarter or full length	All types
	Inches	*Inches*	*Inches*	*Inches*
4×5	6.4	9	6.4	19.2
5×7	8.6	12	8.6	25.8
8×10	12.7	18	12.8	38.4

3-11. How to Select the Proper Background

a. For identification portraits the background should be plain white or neutral gray.

b. For formal personnel portraits use a plain white or neutral gray background. The background should *not* have any pattern; on the other hand, though, a monotone is dull, uninteresting, and undesirable. You can get around this contradiction of no pattern and no monotone by varying the brilliance of the background. By properly positioning lights, you can produce one of the following or some other effect that will improve your portrait without placing any detail in the background:

(1) A light background behind the subject

that fades into a darker background at the edge of the photograph.

(2) A light background just above the shoulders that fades into a darker background at the top of the photograph. The change from light to dark should be too grandual for anyone to see where the change takes place.

c. The lightness or darkness of the background depends on the subject and his clothing. You can add depth to a portrait by having a distinct separation between subject and background. For this separation, the background should be either darker or lighter than the subject. *For example,* the background could be light just above the shoulders of a dark uniform and gradually fade to a dark background around the subject's light blond hair.

d. As a background for informal personnel portraits you should have an uncluttered scene that indicates the subject's job or position. *For example,* picture a pilot with a plane in the background, an instructor with a blackboard in the background, or a commanding general seated at his desk with a map or picture of his command on the wall. The background should not be so detailed or complex that it distracts from the subject. In fact, you might even consider having it out of focus to reduce the sharpness.

e. Be especially careful not to include any classified material when you are photographing in or around a security area. Avoid accidentally causing a security violation by knowing beforehand what is in the background.

f. Now that you have selected an appropriate background for your portrait, it's time to position your lights.

Section III. LIGHTING

3-12. Flood or Flash, Which to Use?

a. Before positioning or arranging lights for a portrait you must, of course, select the type of light. This is not a critical choice because you can make a photograph with almost any amount of light if the exposure is long enough. The amount of light you need can be produced equally well with either photoflood lamps, flashbulbs, or electronic flash. Generally speaking, you should illuminate the subject much brighter than an average scene so that you do not have to work with excessively slow shutter speeds and wide lens openings. But, remember too, if you use high wattage lamps at close distances it is uncomfortable for the subject, difficult to control, and results in poor portraits.

b. Photoflood lamps are preferable for studio and formal portraits because you can light the lamps while you are arranging them and posing the subject. Since you can see just exactly how the photoflood lamps will illuminate the subject, you don't have to guess about the lighting effect in the finished photograph. Characteristics of various floodlamps are given in table 3-II. The watts rating of a floodlamp is a rough indication of the light output, but because its light output decreases with usage, you should use an exposure meter to determine the amount of exposure. The standard lamp socket fits a medium screw base. We will discuss color temperature in chapter 9.

c. Flashbulbs are easier on the subject than photoflood lamps. With flashbulbs the subject doesn't have to stand under hot lights, and the exposure is complete before he can react to the brightness. Another advantage is that flashbulbs and holders are much more portable than photoflood lamps and stands. Characteristics of various flashbulbs are given in Chapter 8, which discusses flash photography.

Table 3-II. Floodlamps

Watts	Lamp	Base	Color temp. (degrees K)
250	Photoflood No. 1	Medium screw	3,400
375	Medium Beam 375W	Medium screw	3,400
500	Photoflood No. 2	Medium screw	3,400
500	Photoflood No. RFL2	Medium screw	3,400
500	Photospot No. RSP2	Medium screw	3,400
500	T-20 (500W)	Medium screw, medium prefocus, and medium bipost.	3,200
500	PS-25	Medium screw	3,200
750	T-24	Medium bipost	3,200
1,000	Photoflood No. 4	Mogul screw	3,400
1,000	G-40	Mogul screw, mogul prefocus, and medium bipost.	3,200
1,000	PS-52 (1,000W)	Mogul screw	3,200
1,000	T-20 (1,000W)	Mogul screw and medium prefocus.	3,200
1,500	PS-52 (1,500W)	Mogul screw	3,200
2,000	G-48	Mogul screw, mogul prefocus, and mogul bipost.	3,200
5,000	G-64	Mogul bipost	3,200

d. An advantage of electronic flash in portraiture is that there is less tendency to burn out the highlights, while the retention of shadow detail is better than with conventional flash. The soft, cool light is excellent for portraiture and affords a minimum of discomfort to the subject.

3–13. Using One Light

a. Figure 3–6 is a portrait that was photographed using only one light. Regardless of how many lights you may finally use, one light is always of principal source of illumination. This is called the *main light,* key light, or modeling light. This light brings out form and texture and determines the exposure.

b. Place the main light in a 45-degree, top, front position so that the shadow of the subject's nose ends between one-third and two-thirds the distance between his nose and lip. The insert in figure 3–6 diagrams a top view of the setup showing where to place the main light (the hemisphere) with respect to the subject (circle) and the camera. What the diagram does not show is that the light is higher than the camera.

c. The portrait (fig. 3–6) shows a slight variation of mainlighting. The nose shadow reaches into the cheek shadow producing a triangular patch of light on the cheek that is away from the light.

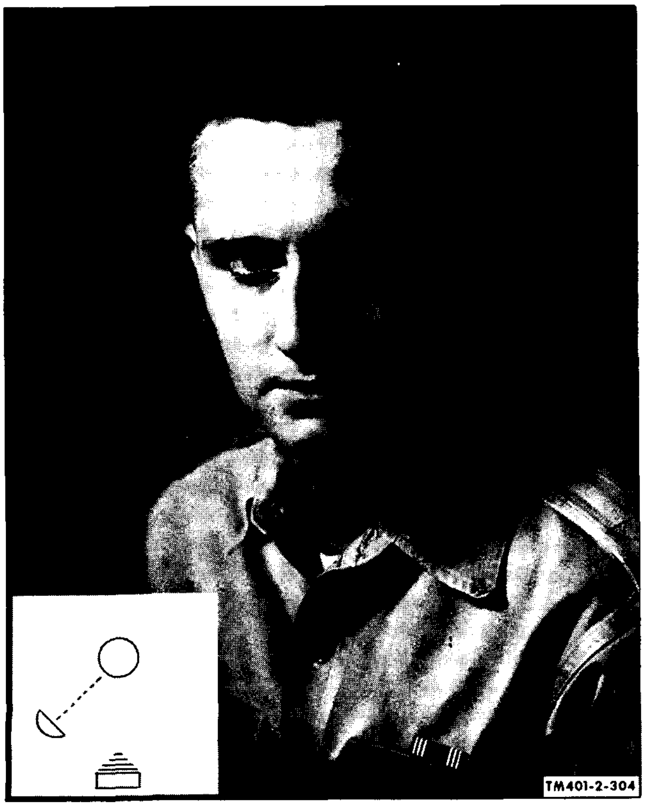

Figure 3–6. Using one light.

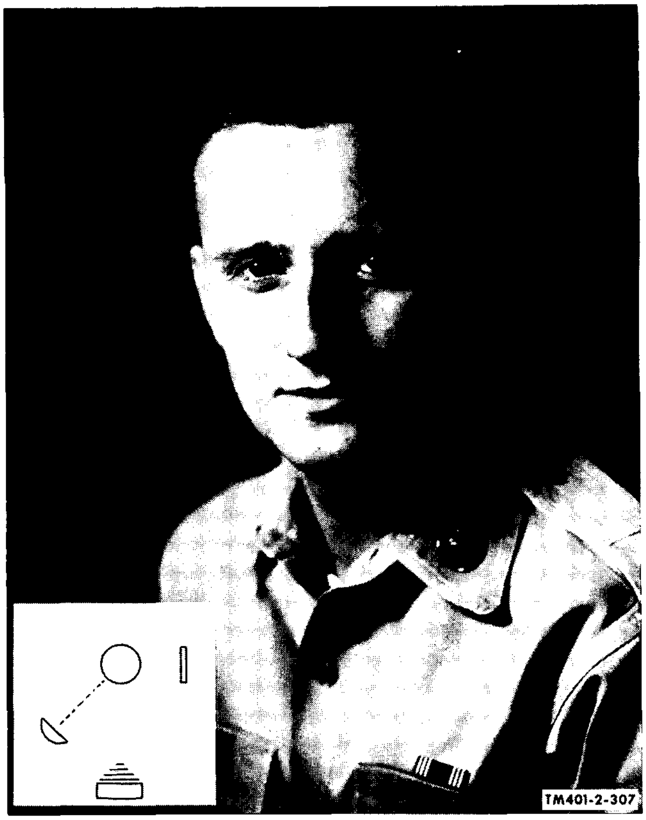

Figure 3–7. One light and a reflector.

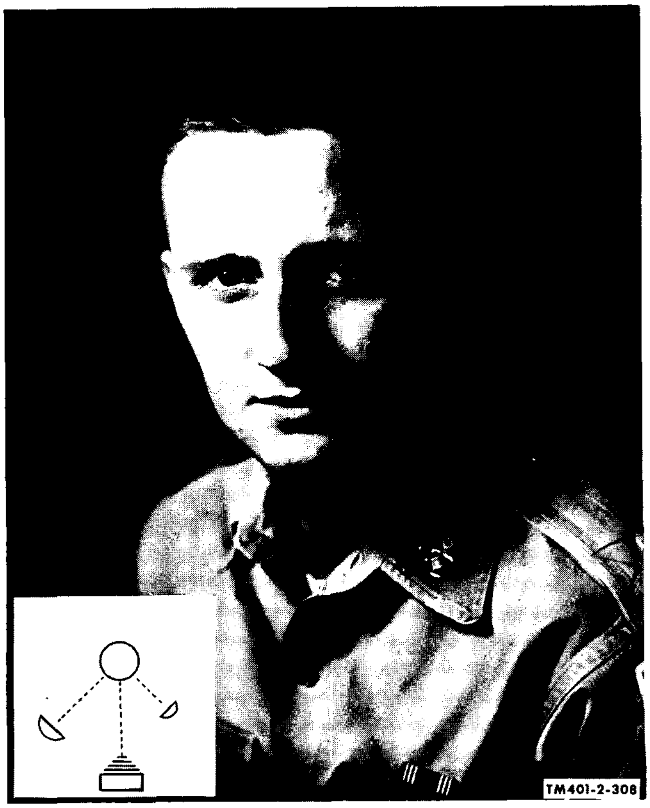

Figure 3–8. Using two lights.

d. You should place the main light either to the right or the left of the camera, depending on which side of the face you want to show up best. But don't move the light too far to the left, right, up, or down. If the light is too far to one side, only one side to the subject's face will be illuminated. A shadow line will appear right down the middle of the subject's face giving the appearance that his head is split in two. If the light is too high, the eye sockets will be dark, and the subject will look like he's been through a rough night. If you place the light too low, the subject takes on a ghostly, monstrous, unnatural appearance. Illumination from below is not common in our everyday experience; lights and practically all natural illumination shine from above.

e. One light is sufficient for a portrait but not desirable. One light forms sharp shadows and hides some detail. Note that the left cheekbone is almost completely invisible in figure 3-6. You can lighten the shadow and bring out some of the detail by using a reflector (fig. 3-7) or another light (fig. 3-8).

3-14. Using Two Lights

a. When using two lights (fig. 3-8), you still have one called the main light. It serves the same purpose and is placed in the same position as when you use only one light.

b. The second light, called a *fill-in light,* fills in or lightens shadows. You place it close to the camera, at or above lens level. The fill-in light should be diffused and scattered so there is *no* direct beam of light.

c. The fill-in light should be weaker than the main light. When you photograph women and children, who should appear soft, and subjects who have deeply set eyes, your fill-in light should be only slightly weaker than the main light. This removes mcst of the shadows. However, you should be careful not to eliminate the physical features of the subject.

d. Normally, use two lights for identification portraits. Use three for personnel portraits to obtain more lighting effects.

3-15. Using Three Lights

a. In a three-light setup the lights are called the main light, the fill-in light, and the separation light. The first two are used as discussed above. The third, the *separation light,* separates the subject and the background, adds depth, and varies background tone.

b. You can use the separation light in three ways: as backlight, as background light, or as a combination of the two.

(1) As *backlight,* the separation light is placed high and behind the subject. The light falls on the back of the subject, highlighting the hair and shoulders. None of the light should shine on the subject's cheeks or ears. (Some light will fall behind the ears but this is not visible to the camera.) The backlight should be stronger than the main light, it should lighten the outline of the subject to separate the subject from the dark background.

(2) As *background light,* the separation light lights only the background (fig. 3-9). It is better to use background light than backlight if the subject has large ears or a bald head because these features will reflect large amounts of backlight and show up noticeably. Background light eliminates shadows to gain distance between, or separation of, subject and background. Place the background light behind the subject so it shines on the background; the exact placement depends on the desired lighting effect or variation of tone. Figure 3-9 shows an example of background light where the background is very light behind the subject and gradually becomes darker toward the top and sides.

(3) A combination of backlight and background light is an excellent type of separation light.

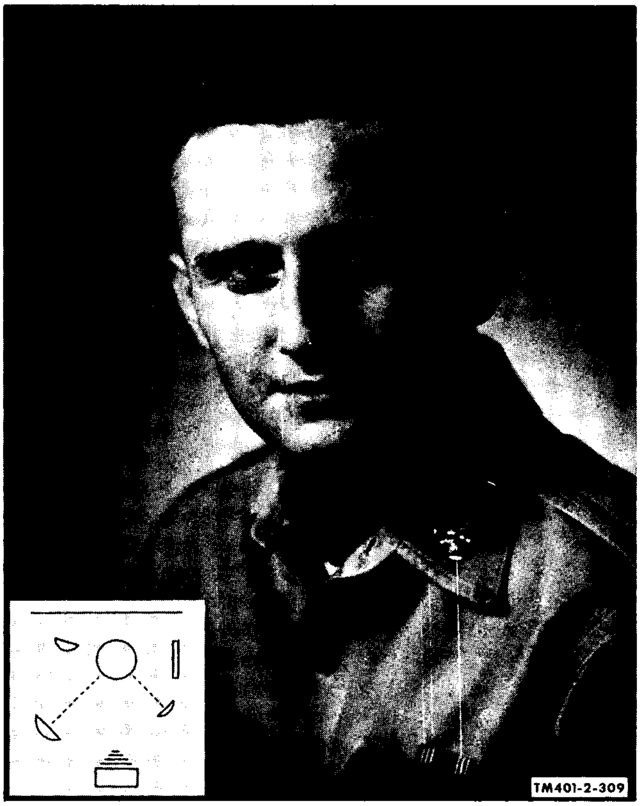

Figure 3-9. Using background light.

3-16. Using Sunlight

a. You can use sunlight as the main light for your portraits. The sun is in the correct position for photography when it's behind the camera and to one side—about 2 hours before or after noon. This, of course, varies with season and latitude.

b. In strong sunlight use a reflector or flashbulb as a fill-in light. This lightens the shadows and brings out facial details.

Section IV. POSING THE SUBJECT

3-17. Tactfully Take Command

a. When posing the subject, you, as the photographer, take command even if the subject outranks you. Be direct and firm but never demanding or offensive. Don't irritate or tax the subject's patience; be tactful and polite. Remember, you are in command only because you know what makes a good portrait.

b. Be courteous even if you outrank the subject. Put the subject at ease; relax him. The smile of contentment in a photograph makes a better portrait than a scowl of anger or a grin of laughter.

c. Direct the subject's movements but *do not* touch him. Tell the subject to turn his head to the right or left, but *don't* move it for him. Don't tire the subject by asking him to pose in uncomfortable positions or for long periods of time. Do as much preparation as possible before the actual sitting so that the sitting only takes 2 or 3 minutes. You can do many things ahead of time to shorten the posing time, like placing the lights in approximately the correct position.

3-18. Check the Subject's Clothing

a. The subject should wear the proper uniform with all his military decorations. A class A uniform is required for identification and formal personnel portraits. Informal personnel portraits may not require class A uniforms, but the dress should always be in accordance with regulations.

b. The subject should be bareheaded for identification, formal, and indoor portraits but can wear a hat, cap, or other headgear outdoors.

c. The subject's clothing should fit properly without bulges or wrinkles. Especially check collars because they tend to turn upward, and sleeves because they tend to wrinkle. Sleeves also tend to ride up on the arm, exposing too much of the wrist or shirt cuff.

3-19. How to Determine Which Side of the Face to Favor

a. The assignment for an identification portrait usually specifies fullface or which profile should show on the photograph. If the assignment does not state or imply which view to use, then select the view that will most clearly show any identifying marks or characteristics. For example, pointed noses and chins show up more in profile than fullface.

b. In personnel portraits you should try to hide blemishes and make the subject look his best. You can hide birthmarks by turning the subject so the marked part of his face is away from the camera or so a shadow falls across that part of his face.

3-20. How to Pose the Subject

a. Don't touch the subject, but tell him how to pose so that every part of his body is properly positioned, even those parts that won't show up in the photograph. It is particularly important to relax the part of the subject that is not in the portrait because any strain will show in the subject's face.

b. The subject should be erect but relaxed. That is, he should stand or sit straight and tall but not stiffly.

c. His feet should be slightly apart, and his trunk should be straight, not twisted.

d. The subject's hands should be relaxed and farther from the lights than his face. When the hand is relaxed, the fingers curve *slightly* toward the palm. A clenched fist or a tight grip on an object is a strain, and when the subject puts his hand in his pockets it pulls his shoulders out of position.

e. Less light should strike the subject's hands than the face. You can accomplish this by feathering or turning the light so only the edges of the beam reach the hands and by using screens or "barn doors" or shields.

f. Your subject's shoulders should be level with the ground. They should be parallel with the film for a fullface identification portrait and perpendicular to the film for a profile indentification portrait. For personnel portraits the subject's shoulders should be at a 45-degree angle with the film.

3-21. How to Position the Subject's Head

a. For an identification portrait the subject's head should be level. He should face straight ahead in the same direction as his trunk.

b. For a personnel portrait the subject may tilt his head. A personnel portrait should not be a fullface view looking straight at the camera, but more of a fullface than a profile; that is, between a 45-degree angle and a fullface. The subject's head should be turned to more of a profile for a flat nose and more of a fullface for a long nose. If a subject's nose curves to the left or right you can make it appear straight by shooting from the side toward which the nose turns.

c. Mainlight the near side of the head for a long face and the far side for a round face.

d. Use shields or barn doors on studio lamp PH–218 to reduce illumination on bald heads. This also permits some flexibility in where you place the light.

e. It's not necessary, but the subject's eyes may look straight ahead in the direction that his nose is pointing. His line of gaze should be level with the ground. In many portraits today the subject is looking right into the lens. This tends to make him look lively and warm, but you must make sure that he looks relaxed.

f. People who ordinarily wear glasses should wear them for their portraits. Even though the subject wears glasses, we still want to see his eyes, so you will have to position his head and your lights so you do not get reflection off the glass. If it is not possible to completely eliminate the reflection then keep it in the upper corner of the glasses so that it can easily be retouched.

3–22. How To Pose a Standing Subject

a. The statements above on posing the subject (paras 3–20 and 3–21) are general and are applicable to both a seated and standing subject.

b. A standing subject is harder to relax so if permissable, have him sit down.

c. If the subject has to stand be sure that his legs are straight but not stiff and that his arms are at his side (except when he is holding something) but not pinned rigidly to his side.

3–23. How to Pose a Seated Subject

a. Paragraphs 3–20 and 3–21 are applicable to a seated subject.

b. A seated subject appears more relaxed and natural in a photograph than a subject who is standing. Thus, for a head and shoulders portrait have the subject sit on a stool or a chair with a low back.

c. The subject may cross his legs if this makes him feel more at ease; however, if his legs show in the photograph the near leg should cross over the far leg. This is because perspective, as you know, causes objects near the camera to appear very large, and a large knee sticking out of the photograph will distract from the rest of the picture and spoil the portrait.

d. The subject should keep his arms and hands relaxed and close to the body. Hands are difficult to pose and photograph properly. Try having the subject fold his hands together in his lap or on his leg or simply rest them on the arms of a chair. Do not let the subject grip his knee or the chair arm. Perhaps you may have to try to hide the hands by letting the hand farthest from the camera hang so that it is hidden by the body. Even if the hands do not show, they should not be in an awkward position because the strain or discomfort may show in the subject's face.

3–24. How to Set The Camera

a. Set the camera at eye level and focus it on the subject's eyes. This level places the print viewer face to face with the subject and centers on the most expressive part of the face—the eyes.

b. Raise the camera slightly when the subject has a double chin or a short nose and lower it slightly when the subject has a long nose or is wearing a hat, but still focus on the eyes.

3–25. Relax Subject Just Before Exposure

a. Posing for a portrait makes some people very nervous and tense. In general, a portrait should not show any extreme of emotion. The subject should be happy and contented but not laughing. Thus you must put the subject at ease and relax him.

b. You should not place the lights so close as to cause the subject extreme discomfort.

c. Have the subject moisten his lips, and then have him say "cheese," or do some other mild, light, humorous action to put a twinkle in his eyes and relax his facial muscles. You want him to have a pleasing, pleasant look, not a toothy smile, which is NOT good for military portraits.

d. Your timing is most important. You must anticipate the subject's peak of expression and be able to trip the shutter as the peak approaches.

3–26. Determining the Exposure

Use standard procedure for determining and making the exposure. This is discussed in TM 11–401–1.

3–27. Processing and Printing

Use the standard laboratory procedures for processing the film and printing. This is discussed in chapter 8 of TM 11–401–1.

Section V. SUMMARY AND QUESTIONS

3-28. Let's Summarize

a. Identification portraits are used for badges, passes, and the like. They show a fullface view or profile, and have either neutral gray or a height scale for background.

b. Formal personnel portraits are used for records, formal display, and informal identification. They show the subject in class A uniform against a plain gray background.

c. Informal personnel portraits are used for display and promotion. They show the subject in his natural environment but not engaged in any activity.

d. Select a camera that will produce a negative 4 x 5 inches or larger. Small cameras are *not* recommended for portraits because of small image size, loss of sharpness in enlarging, and difficulty of retouching the negative.

e. Identification Set AN/TFQ-1B and Still Picture Camera Set KS-19A(1) are complete sets used for identification portraits.

f. Still Picture Camera Set KS-17A, which is a view camera, and Still Picture Camera KE-12(2), which is a general purpose camera, are both used for personnel portraits.

g. For a head and shoulders portrait, use a focal length lens equal to or greater than the sum of the long and short film dimensions.

h. For a three-quarter or full length portrait, use a focal length lens equal to or greater than the film diagonal.

i. Place the main light in a 45-degree, top, front position to bring out form and texture.

j. Place the fill-in light near the camera, at or above the camera height, to bring out details hidden in the shadows.

k. Place the separation light behind the subject as a backlight, a background light, or a combination of both.

l. Tactfully take command of the posing. Without touching the subject, pose all parts of him in a natural position.

m. The subject should wear a proper, well-fitted uniform.

n. Favor the side of the subject's face that shows him at his best.

o. Seated subjects are more relaxed and natural than standing subjects.

p. Usually set the camera at about eye level.

q. Relax the subject just before the exposure.

3-29. Review Questions

Answers to these review questions are in paragraph 3-30.

a. Name three types of portraits, a camera to use for each type, and the type of background for each.

	Type	*Camera*	*Background*
(1)	---------	---------	---------------
(2)	---------	---------	---------------
(3)	---------	---------	---------------

b. What is the smallest size lens you should use with a 4- x 5-inch film for a head and shoulders portrait? ____________. For a full length portrait? ____________.

c. What is the proper action to take for each of the following characteristics?

	Characteristics	*Actions*
(1)	-- Double chin	(*a*) Turn head to side
(2)	-- Flat nose	(*b*) Keep lights low
(3)	-- Crooked nose	(*c*) Raise camera
(4)	-- Short nose	(*d*) Lower camera
(5)	-- Long nose	(*e*) Cast straight nose shadow
(6)	-- Long face	(*f*) Cast long nose shadow
(7)	-- Round face	(*g*) Use strong fill-in light
(8)	-- Bald head	(*h*) Avoid reflection
(9)	-- Deeply set eyes	(*i*) Mainlight near side
(10)	-- Glasses	(*j*) Mainlight far side

d. Name the lights shown in the diagram of figure 3-10.

e. Name the type of portrait shown in figure 3-11 and list as many things wrong with the portrait as you can.

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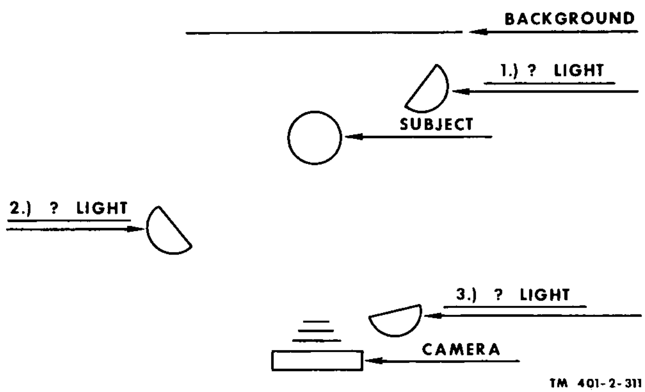


Figure 3-10. Lighting diagram.

Figure 3–11. A poor portrait.

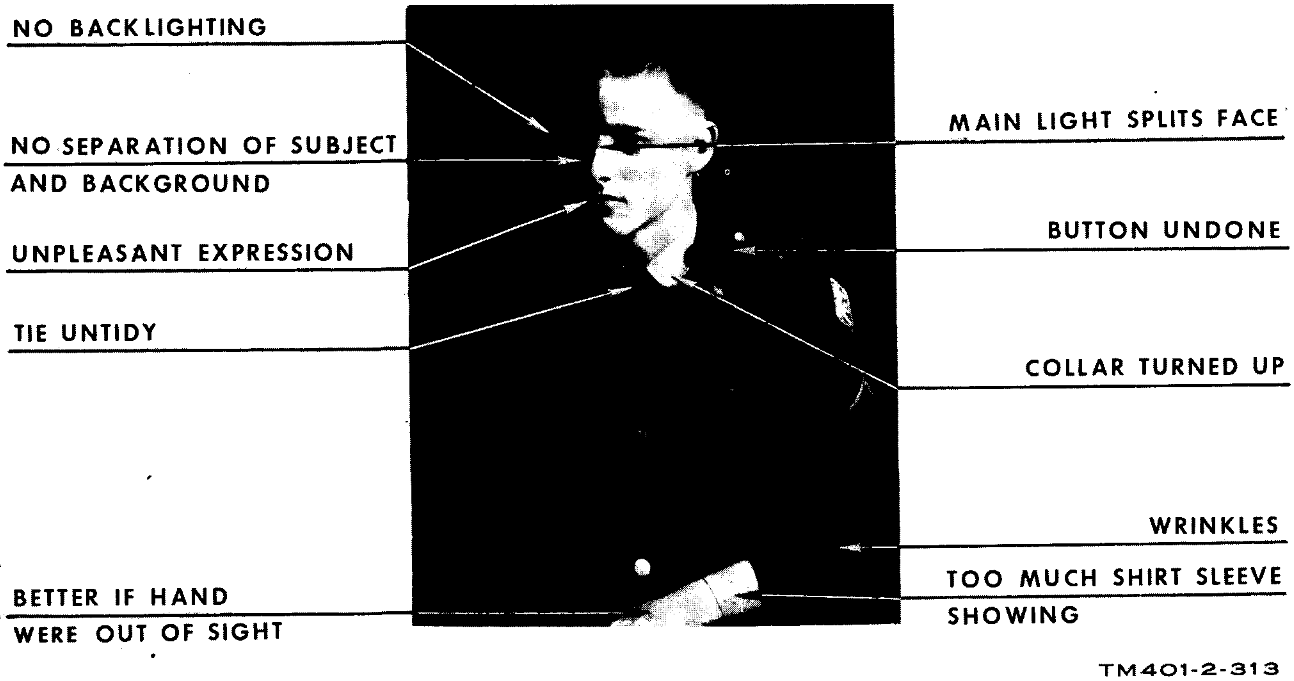


Figure 3–12. Answers to problem in paragraph 3–29e.

3–30. Answers to Review Questions

a.

	Type	*Camera*	*Background*
(1)	Identification	AN/TFQ—1B or KS–19A(1)	Plain
(2)	Formal personnel	KS–17A or KE–12(2)	Plain
(3)	Informal personnel	KS–17A or KE–12(2)	Natural environment

b. 9-inch 6.4-inch

c.

Characteristics	Actions
(1) c Double chin	(*a*) Turn head to side
(2) a Flat nose	(*b*) Keep lights low
(3) e Crooked nose	(*c*) Raise camera
(4) c,f Short nose	(*d*) Lower camera
(5) d Long nose	(*e*) Cast straight nose shadow
(6) i Long face	(*f*) Cast long nose shadow
(7) j Round face	(*g*) Use strong fill-in light
(8) b Bald head	(*h*) Avoid reflection
(9) g Deeply set eyes	(*i*) Mainlight near side
(10) h Glasses	(*j*) Mainlight far side

d. The names of the lights in figure 3-10 are—

(1) Separation or background light.
(2) Main, key, or modeling light.
(3) Fill-in light.

e. Refer to figure 3-12.

CHAPTER 4

GROUP PHOTOGRAPHY

4–1. Introduction

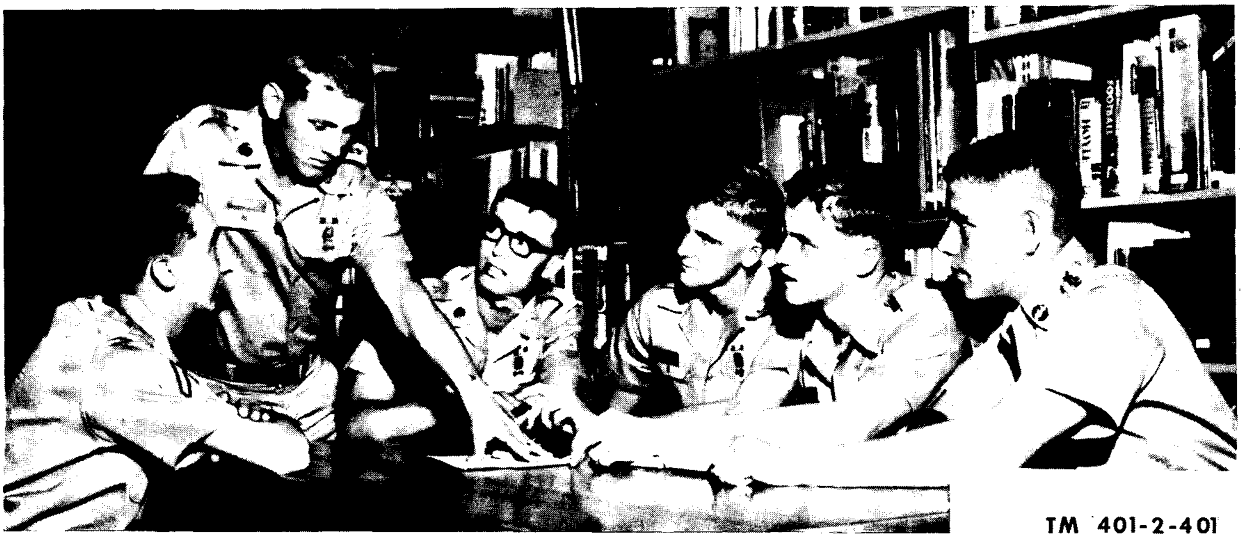
Group photographs are classified as either formal or informal. They are made for official records, publicity, recruiting, and the personal possession of group members.

a. A *formal group photograph* is one in which several people, uniformly dressed, are seated or standing in similar poses (A, fig. 4–1).

b. The people in an *informal group photograph* appear casually unprepared for the photograph; all poses, however, are carefully prearranged (B, fig. 4–1).

A

B



TM 401-2-401

Figure 4–1. Formal and informal group photographs.

4–2. Use an 8- x 10-Inch Camera

a. An 8- x 10-inch view camera is most suitable for group photography, particularly if there are more than five individuals in the group. However, a 4- x 5-inch view camera is acceptable if an 8- x 10-inch one is not available. For smaller groups, a camera that produces a smaller negative is satisfactory. The camera must be big enough so that the faces of the subjects are recognizable in the print.

b. Once you have selected your camera, the next thing to do is to select the proper lens.

4–3. How to Select the Proper Lens

The focal length of the camera lens depends on the size of the group and the distance between the camera and the group.

a. If your operating space is limited and the group is large, use a short focal length lens even though it introduces problems of distortion and perspective.

b. If operating space is no problem, use a medium focal length lens. Place the camera just far enough away so that the group fills the negative space. This positioning keeps distortion to a minimum.

c. Use a long focal length lens to photograph a group from a distance. *For example,* suppose you are photographing a group participating in a military ceremony. By using a long focal length lens and selecting a distant camera viewpoint, you will not interrupt the ceremony and will still be able to properly frame the image.

4–4. Background in Harmony With Group

a. The background you select should be in harmony with the group. It may show some activity identifiable with the group or it may serve simply as a pictorial setting. It should not, however, detract interest from the group.

b. Select a background that does not show restricted areas of a military installation. A picture with such a background cannot be used without extensive retouching to remove the restricted area.

c. A plain background such as a brick wall, an embankment, or the side of a building is preferable. Low angles are undesirable for groups, but you may use them to allow the sky to serve as background for an outdoor photograph of a small group.

4–5. How to Arrange the Group

You should arrange the group according to prevailing military customs. We recommend the following guidelines:

a. Arrange a formal group symmetrically. If you must consider rank, then either place the highest ranking man in the middle with a decrease in rank toward both ends, or place the highest ranking man on the left with a decrease in order of rank to the right. When the group is more than one row deep, rank decreases to the rear. If you can disregard rank, arrange a standing group according to height with the tallest men either in the middle or at both ends. If the group is seated, height makes little difference, and you can arrange the group to obtain a symmetrical pattern.

b. In a formal group, pose the subjects uniformly. Hands and feet should be placed in similar fashion, hats should be at the same angle, and all eyes should be turned in the same direction. When the row is long (over five subjects in a row) and the camera is centered on the group, have the subjects on the ends turn slightly toward the center to retain attention within the group.

c. In an informal group photograph, the activity is usually more important than the people involved. To foster this impression, members of the group should not look as if they are posing. Achieving this natural pose will depend on your ingenuity.

4–6. Arranging Large Groups

a. To photograph a large group, arrange the group row by row on steps or platforms with each row slightly higher than the one preceding. Place the camera above and pointing down on the group.

b. Bear in mind that a camera placed directly in front of the group will make the people in the center of the rows appear larger than those at the ends. As a result, the group will appear to be in a V-formation. The following techniques will help you eliminate the V-effect:

(1) One method is to place the camera in the center of the group and arrange rows in semicircles around the camera. In this arrangement each person will appear normal size because each is the same distance from the camera.

(2) Another method is to place the camera to one side of the center of the group. The rows will now record as straight lines; however, people on the near end of the group will appear larger, and those toward the far end will appear progressively smaller.

c. When you photograph down from a fairly high vantage point, the subjects may appear to be leaning forward or sideways in the picture. You can correct such distortion by using the swing adjustments and the rising and falling front of the view camera. In addition, the swing adjustments will give a maximum depth of field.

4-7. Lighting for Indoor Group Photography

You can take indoor group photographs with natural light, artificial light, or a combination of both.

a. If a large indoor room or hall has enough windows to give a pleasing natural light, you can photograph a group indoors without artificial lighting. If there is not enough natural light but ordinary artificial illumination in the room is satisfactory, then use the existing light to best advantage.

b. No matter whether you use flood or flash lighting, you must uniformly illuminate the group. One light next to the camera may be adequate for small groups, but you may need additional lights for large groups. To avoid undesirable shadows cast by the heads of individuals in the front row, raise the lights above the camera level. You may substitute flashlamps if you can raise them above the camera.

c. Lighting for large groups requires multiflash or powerful floodlights. However, you need not use high shutter speeds because the figures appear small and any movement during photographing is negligible on the finished print.

d. When you photograph small groups indoors with artificial light, backlighting often helps to make the picture more interesting. If the amount of light is limited, you can effectively illuminate the group by placing the main lights in front and by illuminating the background. By this means, you clearly separate the background from the group.

4-8. Lighting for Outdoor Group Photography

a. A hazy, bright day provides the best light for photographing a group outdoors (fig. 4-2). Photographing outdoors should be conducted during the early or late part of the day when the sun is at a 45-degree angle to the horizon. If you photograph in the middle of the day, overhead light will produce deep shadows under cap visors or helmets and will require additional illumination.

b. Position the group to obtain an overall uniform illumination without excessive shadow. If contrast is too great, use synchroflash to fill in the shadows.

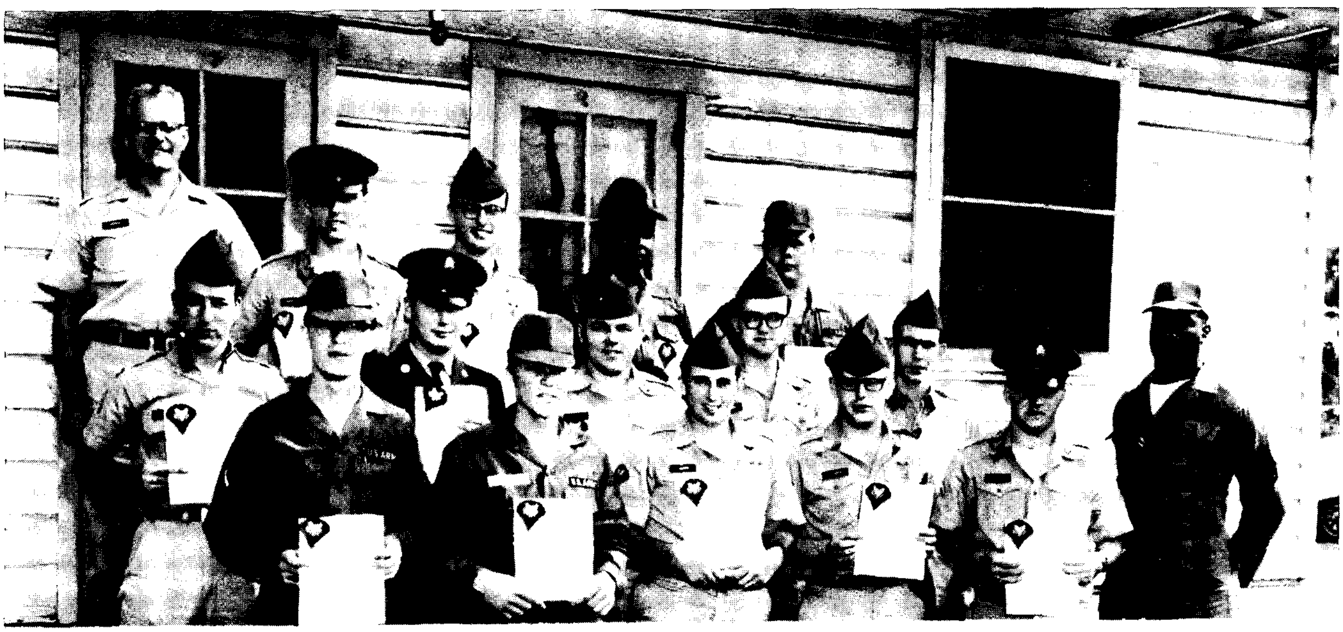
4-9. Review Questions

Supply the missing words or groups of words to the statements below.

a. Group photographs are classified as either ____________ or ____________.

b. For groups of five persons or more an ____________ camera is most suitable.

c. A short focal length lens is suggested when operating space is ____________ and the group is large.



TM 401-2-402

Figure 4-2. Group photograph taken outdoors.

d. The background you choose should be in ____________ with the group.

e. If you were assigned to take a group picture of the commanding general and his staff and preferred to place the general in the center, you would arrange the group by rank with decreasing rank to the __________ and to the __________.

f. To make the activity seem the important thing in the picture, members of the group should not appear to be ____________.

g. Indoor photography can be accomplished with ____________ light, ____________ light, or ____________.

h. Photographing outdoors should be conducted during the _____________ or _____________ part of the day when the sun is at a ___________ to the horizon.

4–10. Answers to Review Questions

a. Group photographs are classified as either *formal* or *informal.*

b. For groups of five persons or more an *8- x 10-inch* camera is most suitable.

c. A short focal length lens is suggested when operating space is *limited* and the group is large.

d. The background you choose should be in *harmony* with the group.

e. If you were assigned to take a group picture of the commanding general and his staff and preferred to place the general in the center, you would arrange the group by rank with decreasing rank to the *sides* and to the *rear.*

f. To make the activity seem the important thing in the picture, members of the group should not appear to be *posing.*

g. Indoor photography can be accomplished with *natural light, artificial light,* or a *combination of both.*

h. Photographing outdoors should be conducted during the *early* or *late* part of the day when the sun is at a *45-degree angle* to the horizon.

CHAPTER 5

COPY PHOTOGRAPHY

Section I. GENERAL

5–1. Introduction

a. What would you do if someone asked you to produce copies of a photograph? It's simple; just get the negative and make some prints. But what if there is no negative? It's still simple; get a camera, photograph the photograph, and then you'll have a negative to make prints.

b. Basically copy photography involves just photographing a picture. In some ways pictures are easier to photograph than real objects. For instance, you do not have to consider depth of field when photographing a picture.

c. Although copy photography procedures are much the same as other photographic procedures, there are some special techniques that you must use to produce good copies. And that is what this chapter is all about—how to make good copies. But first, let's expand our definition of copy photography because it really includes more than photographing photographs.

5–2. What You Copy is the Original

a. Copy photography is the reproduction of any flat *original* such as a photograph, drawing, chart, map, or written document. The original may be strictly black and white like the words on this page, or a pen and ink drawing. Usually, if there are only two tones in the original, one light and one dark, it is called a *line original.* If there are more than two tones, various shades of gray, or color, in the original, it is called a *continuous-tone original.* Thus, the original you copy is a flat (two-dimensional) object and may be line copy (only two tones) or continuous-tone copy (many shades).

b. The negative that you produce from the original is called the *copy negative,* and the print is called the *copy print.*

5–3. Scale is Reduction or Enlargement

a. The copy may be smaller, the same size, or larger than the original depending on the reason for copying. Microfilming is a copy process that reproduces the original in a very small image to save storage space. A need for many copies usually requires the same size reproduction. And to examine fine details, you need an enlargement. The amount of enlarging or reducing should be done exactly to a requested scale because the copy print may become part of a larger document or, in the case of maps, be used to measure distances.

b. Scale is expressed as a ratio of one dimension of the original to the same dimension of the copy. A scale of 3:1 means the original is three times larger than the copy, a ratio of 1:1 says the original and the copy are the same size, and a scale of 1:2 means the original is smaller than the copy by one-half. To remember which number in the ratio belongs to which item, remember that you must have an original before you can make a copy. Thus the original comes first in time and first in the ratio. An 8 x 10 original copied to a scale of 2:1 produces a copy print that is 4 x 5.

c. Another way of stating the scale is to express the amount of reduction or enlargement. For example, a 2X reduction of an 8 x 10 original is a 2:1 scale or a copy size of 4 x 5. In another example, a 2X enlargement is a scale of 1:2 and means that the dimensions of the original are multiplied by two.

5–4. Copy Photography can Help Improve Quality

a. Illustrations for books are originally drawn large and then reduced by copy photography because the small errors in the large original will not be so noticeable in the reduction. And, if you enlarge photographs the flaws show up large and are then easier to retouch. Thus, you see that copy photography can help improve picture quality.

b. Originals that are stained, smudged, or yellowed through age can be improved in the copy provided the stains are transparent. By using the proper filter, you can blend unwanted defects into the picture and perhaps make them disappear completely. You can also increase the contrast of a faded original in the copy by using high contrast film.

c. The main purpose of copy photography is to provide a number of copies for distribution or to provide working copies to protect the original from excessive handling. However, we have seen that copy photography is not limited to providing extra copies. It can also aid in improving quality by increasing contrast, eliminating stains or smudges, and deemphasizing flaws.

5-5. Copy Photography Methods

a. One-to-one scale copies can be made without a camera by *reflex copying.* This method is ordinarily used only for line copy but may be used for continuous-tone copy if poor quality is acceptable (para. 5-22).

b. Transparencies and negatives can also be copied without using a camera (para. 5-21).

c. The standard method of copying is to photograph the original with a camera, process the film, and make prints. The next few paragraphs of this chapter discuss the standard copying procedure in the order that the steps are performed. That order is as follows:

(1) Select the camera.
(2) Select the lens.
(3) Select the filter.
(4) Select the film.
(5) Mount the original.
(6) Adjust the lights.
(7) Adjust the camera.
(8) Determine the exposure.
(9) Expose the film.
(10) Process the film.
(11) Make the prints.

Section II. EQUIPMENT

5-6. Select the Camera

a. Basically, a copy camera should use a large film size, be able to focus on very close originals, and be rigidly mounted.

b. Still Picture Camera Set KS-7(2) is a studio, view copy camera mounted on a cabinet with an easel (copyboard) hinged to one end of the camera bed (fig. 5-1). The camera uses either 8- x 10-inch or 4- x 5-inch film, which can be positioned either horizontally or vertically. The lens can be set anywhere between 15 and 60 inches from the copy to get a scale between a 4:1 reduction and a 1:4 enlargement. The image is focused on ground glass. The two negative sizes, flexibility of the camera, and positive precision movement make this an excellent copy camera set.

c. Still Picture Camera Set KS-7(1) is almost identical to Still Picture Camera Set KS-7(2). The only difference between the two models is in the mechanical construction of the support structure. *For example,* the easel is hinged on the Still Picture Camera Set KS-7(2) and permanently mounted on the Still Picture Camera Set KS-7(1).

d. For field use, when a copy camera is not available, Still Picture Camera Set KS-4A is recommended. This is a 4- x 5-inch press-type camera with the accessories required for general purpose photography.

5-7. Select the Lens

a. The lens you use for copying should be an anastigmatic lens (apochromatic for color) of medium speed. The focal length of the lens should be slightly longer than the diagonal of the film to allow for good working distance and greater definition in the corner of the negative. When you are enlarging, the original should be less than two focal lengths from the lens. The short distance restricts the placement of lights.

b. Still Picture Camera Sets KS-7(1) and KS-7(2) both use anastigmatic lenses with a speed of f/6.3.

c. To get fine detail you should use a small aperture. The best opening to use is two stops from the largest aperture.

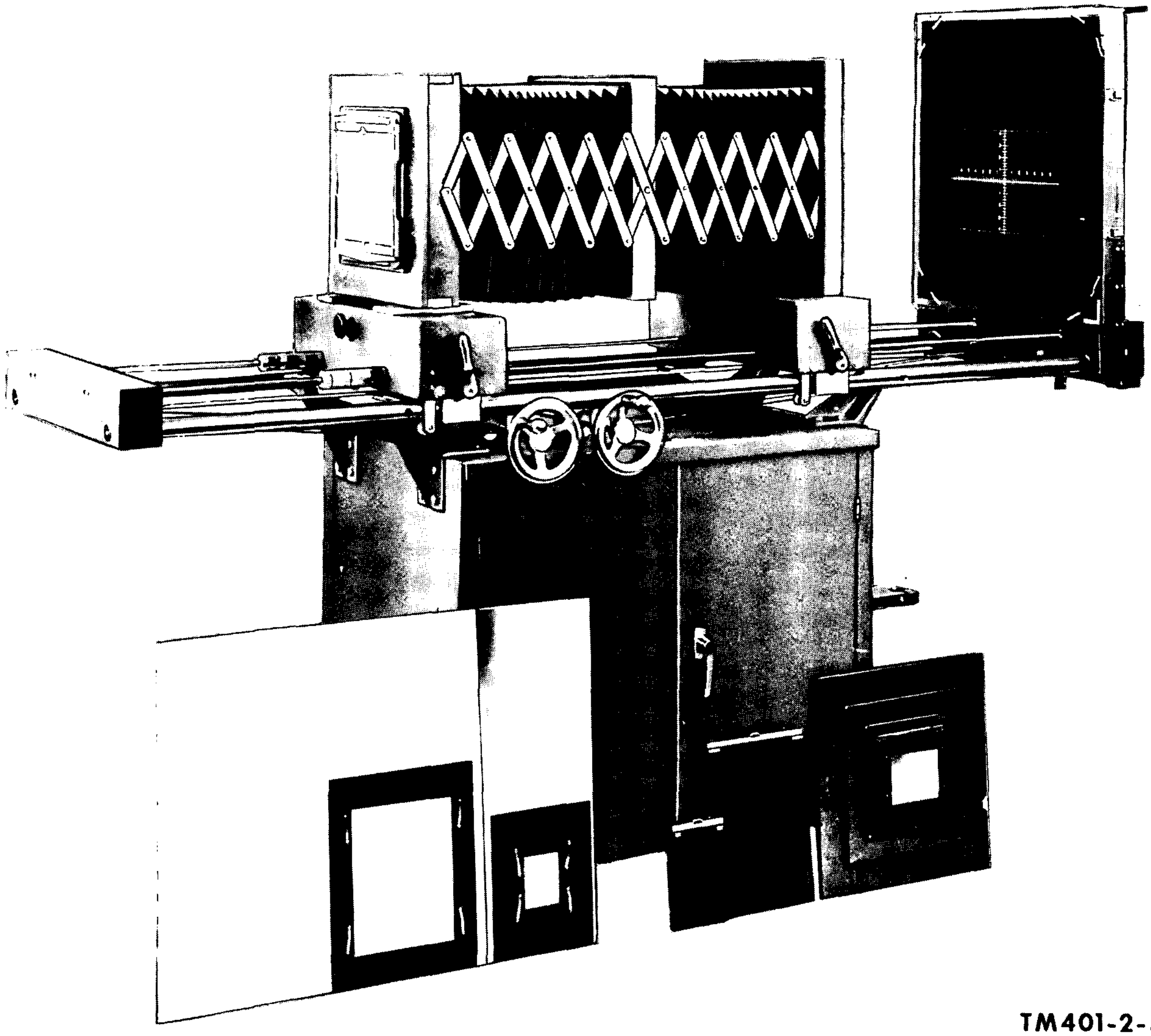
5-8. Select the Filter

a. It is best that you use a K-2 filter for pan film with daylight illumination of multicolored originals and an X-1 filter for pan film with tungsten illumination.

b. You can either increase or decrease the contrast in a copy of a multicolored original by filtering. With line copy it is usually desirable to have as much separation of the tones as possible; in other words, a very sharp contrast. On the other hand, you may want to reduce the contrast in line copy in order to filter out unwanted marks that may appear in the original. Also you can eliminate stains by filtering and can make lettering more readable by making the letters either lighter or darker than the background.

c. The general rules for adjusting contrast of a multicolored original with filters are as follows. To lighten an area use a filter of the same color. To darken an area use a filter of the complementary color. And to eliminate stains use the same color as the stain but slightly darker.

d. Table 5-I gives specific filters to use for particular situations. *For example,* when the original has blue lines on a white background, use a C5 filter to blend the lines with the base or to make the lines disappear. In the same example



TM401-2-501

Figure 5-1. A copy camera.

you could use an A or an F filter to contrast the line with the base and make the lines more visible. What filter would you use to make red lines fade into a blue background?

e. To make red lines fade (blend or disappear) into a blue background, use a B filter. This is because a B filter is green and will darken both red and blue. Table 5-II shows the lightening and darkening effects of some filters.

5-9. Select the Film

a. The proper film will aid the filter's work and may even eliminate the need for a filter. Non-chromatic and orthochromatic films record red as black so there would be *no* need to filter out red marks on a black background if you used these films. The improper selection of film could

Table 5-I. Filter Selection by Line and Background of Original

Background or base color	Line color	To blend line with base use filter	To contrast line with base use filter
White	Blue	C5	A or F
White	Green	B	A or F
White	Red	A or F	C5
Black	Blue	A or F	C5
Black	Green	F	B
Black	Red	C5	A or F
Blue	Green	A or F	B or C5
Blue	Red	B	C5, A or F
Green	Blue	A or F	B or C5
Green	Red	G or C5	B, A or F
Red	Blue	B	C5, A or F
Red	Green	G or C5	B, A or F

Table 5-II. Effects of Filters

Filter	Color of filter	Lightens	Darkens
A	Red	Yellow, orange, red	Blue, green
B	Green	Green	Blue, red
C5	Blue	Blue	Green, yellow, orange, red
F	Dark red	Yellow, orange, red	Blue, green
G	Dark yellow	Yellow, orange, red	Blue
K1	Light yellow	Yellow, orange, red	Blue
K2	Medium yellow	Yellow, orange, red	Blue
X1	Light green	Green	Blue, orange, red
X2	Medium green	Green	Blue, orange, red

hinder filter operation and even destroy the quality of the copy if *no* filter is used. An extreme example of poor film selection is the use of ortho film for red copy or using ortho film through a red filter because ortho film does *not* respond to the color red.

b. Different types of film are used for line and continuous-tone copy. High contrast film (along with high contrast developer) is used to get maximum separation of the tones in line copy. Generally, use nonchromatic process film to copy black and white line copy, and use process pan and process ortho films for colored line copy originals. Use commercial film to produce shades of gray in continuous-tone copy.

c. Table 5-III lists some types of film that can be used for specific types of copying. The table shows that many types of film can be used for a given type of work. The first type of work listed, copying black and white line copy to a scale of 1:1 without a filter, can be performed with any of the group A type films. However, the third type of work, copying black and white or colored line copy to any scale using a yellow filter, requires that one of the last four types of film in group A be selected. What type of film should you use for a black and white continuous-tone copy when a B (green) filter is being used to hide some green pencil marks on the background?

5-10. Do not Interchange the Two Film Groups

a. The answer to the question in the preceding paragraph is commercial pan or panchromatic film. These are the best choices, but they are not the only choices. You could use other films in group B, continuous-tone copy films, but the quality would not be as good as the two choices suggested above. However, you should *not* use

Table 5-III. Selection of Film for Copying

Type of work	Type of film	Commercial name
GROUP A—Line copy		
Black and white only, no filter, and 1:1 scale.	Reflex copy*	Kodak Reflex Copy Paper.
Black and white only, no filter, and any scale.	Photomechanical regular and thin base.	Ansco Reprolith, Kodalith.
	Process	Ansco Process, Defender Process.
Black and white, or color, using yellow filter, and any scale.	Photomechanical orthochromatic	Kodalith Ortho.
	Process orthochromatic	Kodak Contrast Process Ortho.
Black and white, or color, using any color filter and any scale.	Photomechanical panchromatic thin base.	Ansco Reprolith Pan.
	Process panchromatic	Ansco Panchromatic Process, Defender Panchromatic Process, Kodak Contrast Process Panchromatic.
GROUP B—Continuous copy		
Black and white only without a filter.	Commercial and commercial matte.	Ansco Commercial, Defender Commercial, Kodak Commercial and Commercial Matte.
Black and white or color with a yellow filter.	Commercial orthochromatic	Ansco Commercial Ortho, Kodak Commercial Ortho.
Black and white or color with any color filter.	Commercial panchromatic	Ansco Commercial Panchromatic.
	Panchromatic	Ansco Isopan, Defender Fine Grain Pan and XF Pan, Kodak Panatomic-X, Portrait Pan, Super Panchro-Press, Type B.

* Reflex copy does not use a camera. See paragraph 5-5.

group A, line copy film, for continuous-tone copy and you should not use group B, continuous-tone film, for line copy. In other words, do not interchange the two groups of films.

b. However, if it is absolutely ncessary you can interchange between groups. But then develop the film according to the type of copy you are making. You develop line copy to the highest contrast and continuous-tone copy to a normal contrast or the lowest possible contrast with line copy film.

c. When both line and continuous-tone copy appear on the same original, it is best to make two identical exposures, one with a group A film and the other with a group B film. The appropriate parts of each negative are then used to make the copy print. If for any reason you cannot make two negatives, then make one exposure of both the line and continuous-tone copy on commercial film.

d. Now that you have an original and have selected a camera with an appropriate lens, a filter if necessary, and the film, it is time to prepare for the exposure.

5–11. How to Mount the Original for Exposure

a. You need to back translucent originals with white paper when there is print on only one side of the original and with black paper when there is print on both sides. Much of the light shining on translucent originals is reflected to the camera, but some of the light goes through the original, is reflected off the white paper backing, and is sent back through the original to the camera. This makes the whites whiter and the blacks blacker. If the original has print on both sides then the light reflected off a white backing would be blocked by the printing on the back of the original and an image of this printing would appear on the film. So you should use a black backing to absorb all the light that passes through an original that has printing on both sides.

b. Mount the original (with its backing) on a copyboard or easel parallel to the film, centered with the optical axis of the lens, upside down, and flat. Place the original parallel with the film to prevent distortion due to perspective. Centering the original with the optical axis of the lens aids in framing and minimizes distortion caused by the lens. The reason you place the original upside down on the copyboard is so that it will appear right side up on the ground glass back and make focusing the camera easier for you. Holding the original flat is most important because any bumps, wrinkles, or other displacement distort the image, create shadows, and produce hot spots just as the curved mirrors do in a fun house at an amusement park.

c. Sheets of plastic are excellent for protecting an original from physical damage and for keeping the original flat during handling. However, do not use plastic coverings on originals when copying because they—

(1) Are seldom optically pure (distort the copy).

(2) Are hard to hold flat (also distort the copy).

(3) Reflect light causing hot spots.

(4) Reflect images of other objects in the room.

d. Be sure to mount the original so it can be uniformly illuminated.

Section III. LIGHTING

5–12. How to Place the Lights

a. Natural lights (the sun or house lamps) are poor for copy work because the light is seldom uniform. If you have to work outdoors, find an open shady area to work in. When using natural light try to place the original so that it gets light from both sides, or use reflectors so the original is illuminated as uniformly as possible.

b. You can check the uniformity of illumination on the original with an exposure meter or by the shadow method described in the next *paragraph. For perfection, the meter reading* must be exactly the same for each point on the original. To be practical, however, adjust the lights so *the meter reading is the same in the center and at each of the four corners of the original.*

c. To check uniformity of illumination by the shadow method, hold a pencil or similar object on and perpendicular to the original. Hold the eraser or blunt end against the original, NOT the sharp end. Observe the shadow. Repeat this process in the center and at each of the four corners. The shadow should look the same in each case.

d. To obtain uniform lighting, use two lights, one on either side of the camera. Place the lights

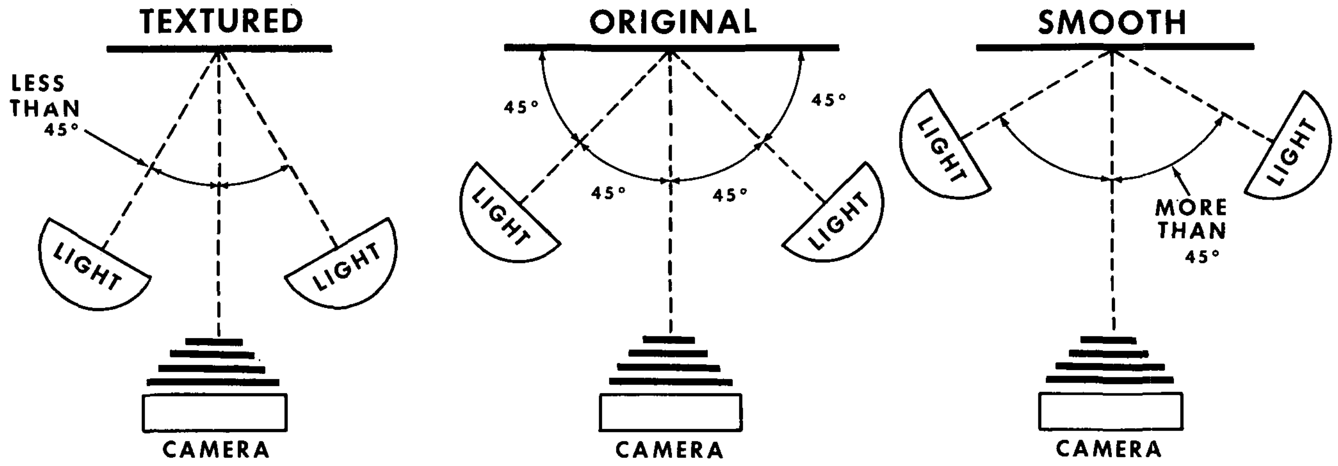


Figure 5–2. Angle for lights.

so there is a 45-degree angle between the light and the original and between the light and the camera as in the middle section of figure 5-2.

e. As shown in figure 5–2, the angle between the light and the camera should be reduced for originals with a textured surface. The angle should be increased when the surface of the original is very smooth. Textured surfaces *diffuse* the light, so you need a more direct light to prevent shadows and to get more light to the camera. Smooth surfaces *reflect light,* so you should use a more oblique light to prevent surface reflections from spoiling the copy.

f. Place the lights equal distances from the original if they are of equal intensity. When the intensity is *not* equal, place the brighter light farther away so the illumination of the original from each light is the same (fig. 5–3). Illumination decreases with the square of the distance. Thus you can obtain the same illumination of the original by placing a light that is four times brighter twice the distance away.

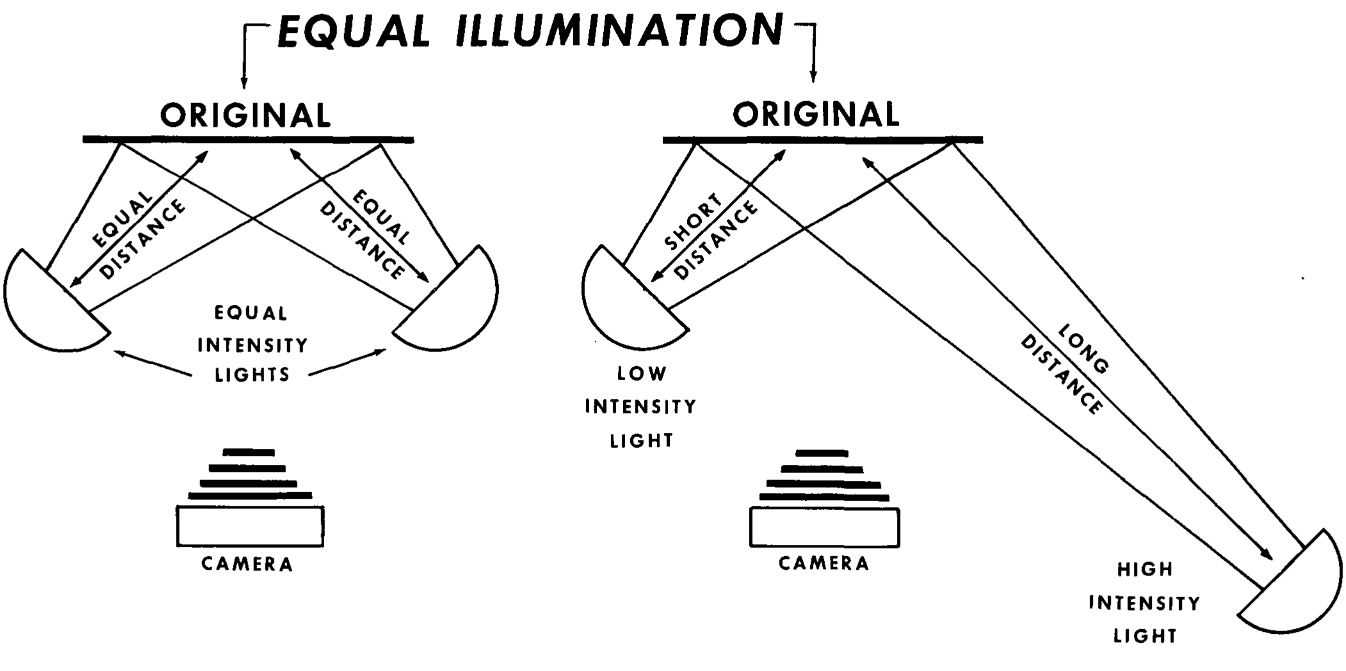


Figure 5–3. Adjust distance to intensity.

g. To achieve uniform lighting, it is better to set the lights away from the original. The center of a beam of light is generally brighter than the outside, so if lights are brought in too close the center of the original may be brighter than the edge (or corners). Distance does reduce the overall brightness, but it makes the illumination more uniform (fig. 5–4). You can also increase uniformity by placing white tissue paper over the light, thereby diffusing the light.

h. Placing the lights farther from the original than the camera also prevents the light from shining directly into the lens and causing hot or bright spots. There are also other ways bright spots can occur. Light on any smooth surface causes a shiny reflection. Do *not* allow this reflection to be picked up by the lens. You can keep the shiny reflection out of the lens by moving the light, moving the reflecting surface, polarizing the light, or using shields.

5–13. Summary of Light Placement

a. The most important point we've discussed is that the original must be uniformly illuminated.

b. The lights are normally placed at an angle midway between the camera and the original, at a smaller angle with the camera for a textured surface, at a larger angle with the camera for a smooth surface, and at some distance from the original for lighting uniformity.

c. Prevent shiny reflections from entering the lens by using shields and polarizers and by properly placing the lights.

d. Natural lighting is poor for copy work but when work must be done outside, copy in an area of open shade.

Section IV. TECHNIQUES FOR MAKING THE COPY

5–14. Next, Focus the Camera

a. Now that all the equipment and materials are in place, focus the camera by observing the image on the ground glass back. Besides focusing for a sharp image, also look for possible defects in the setup such as—

(1) Perspective distortion caused by the original not being parallel to the film plane.

(2) Distortion caused by an original that is not flat.

(3) Hot spots caused by shiny reflections.

(4) Improper framing caused by poor alinement of original.

(5) Reflection of camera from glass-covered easel.

b. After focusing, determine the exposure.

5–15. How to Determine the Exposure

a. First determine the basic exposure. Multiply the exposure meter reading by five for line copy. Or, use the gray card reading or middle tones directly for continuous-tone copy.

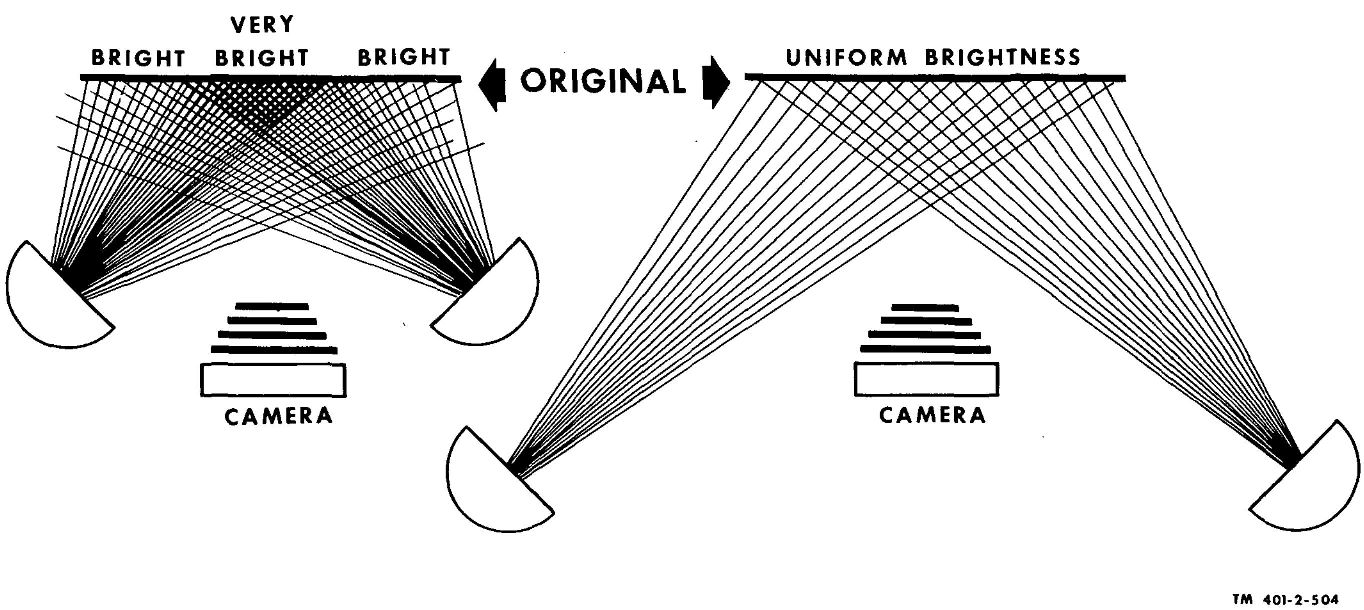


Figure 5–4. More distant, uniform lighting.

b. Then, multiply the basic exposure by the filter factor.

c. When the original-to-lens distance is less than 10 times the focal length of the lens, as it will be most of the time, you must multiply the exposure by the bellows extension factor. There are two methods of calculating the bellows extension factor.

(1) *The first method.* Measure the bellows extension (BE) (distance from lens to focal plane), divide by the focal length (FL) of the lens, and then square the result. Stated as a formula, this is:

$$\text{Bellows extension factor} = \left(\frac{\text{BE}}{\text{FL}}\right)^2$$

For example, if the bellows extension is 508 mm and the focal length is 305 mm then:

$$\text{Bellows extension factor} = \left(\frac{508}{305}\right)^2 = (1.67)^2 = 2.8$$

(2) *The second method.* Divide the image size by the original size, add one, and then square the result, as shown by the following formula.

$$\text{Bellows extension factor} = \left(\frac{\text{image size}}{\text{original size}} + 1\right)^2$$

For example, if the image is 8 inches high and the original is 12 inches high, then the—
Bellows extension factor

$$= \left(\frac{8}{12} + 1\right)^2 = (.67+1)^2 = (1.67)^2 = 2.8$$

If you are to make a 2X reduction of an original that is 8 x 10 inches without a filter and with a 150-mm lens, the bellows extension would be 225 mm. What shutter speed should you use if the basic exposure is 8 seconds at f/16 and you do not want to change the f-stop? Work the problem twice using both of the above methods.

5-16. Answer to Exposure Problem

Using the first method on the problem above we find that the bellows extension factor is $(225/150)^2$ or $(1.5)^2$ or 2.25. Using the second method the bellows extension factor is

$$\left(\frac{1}{2} + 1\right)^2$$

or $(1.5)^2$ or 2.25. Thus with either method the time of the exposure should be multiplied by 2.25 and the shutter speed would be 2.25 x 8 or 18 seconds.

5-17. Make More Than One Exposure

a. You should make trial exposures of ¼, ½, 1, 2, and 4 times the estimated exposure. All five exposures can be made on one negative by placing a piece of opaque material over all but 1 inch or so of the negative. After each exposure of about ¼ of the exposure time you expect you will need, move the covering material another inch. The result will be a single negative with five different exposures as shown in figure 5-5.

b. If time does not permit you to make and develop a trial negative, then make three separate exposures—one at the estimated exposure, one three stops underexposed, and one three stops overexposed. One of the three exposures should produce a good copy.

c. When using commercial pan film for line copy, underexpose two stops and overdevelop 50 percent to get high contrast and sharp, deep blacks. Also, use a high contrast developer, such as D-8, D-11, or D-19.

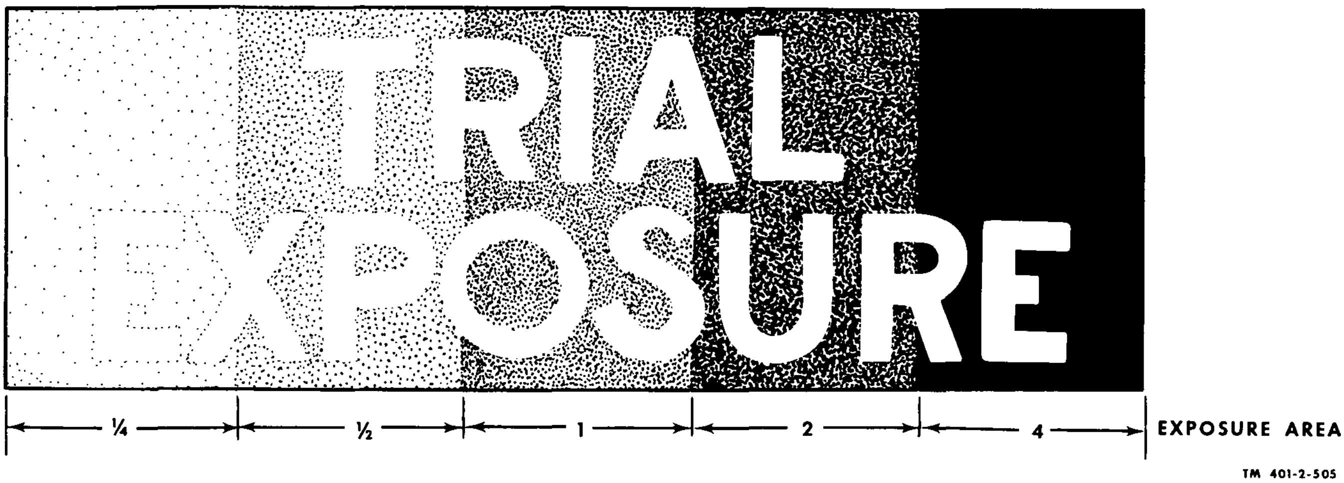


Figure 5-5. A trial negative.

5-18. Next, Process the Film

a. You use the standard process for developing, fixing, washing, and drying the film with the following exceptions:

(1) Develop line copy to the highest contrast.

(2) Develop continuous-tone copy to slightly less than normal contrast.

b. If light areas of line copy show fog, they may be treated with R-4, Farmer's Reducer.

5-19. Finally, Make the Prints

a. The principal difference in types of copy prints is that line copy has very high contrast and continuous-tone copy has a normal contrast.

b. As we mentioned before, some originals may contain both areas of line copy and areas of continuous-tone copy, such as a picture alongside printed text. These are best copied by making two exposures, one on line copy film and the other on continuous-tone copy film. Then the two negatives are used to make one print by one of the following methods.

(1) *Method one.* Mask the portion of each negative that will *not* be used. Then expose the print twice, once with each negative. This is not a double exposure because the masked areas of the negatives keep light from striking the print. Carefully aline the print paper and each negative to get the line copy and the continuous-tone copy in the proper position with each other on the print. You can do this by hinging the negatives (fig. 5-6).

(2) *Method two.* Cut away the unwanted parts of both negatives so the two negatives can be taped together to form one. This is called splicing or stripping. Use red cellophane tape for opaque areas and clear cellophane tape for transparent areas.

5-20. Summary of General Copying Procedures

a. Select the camera and lens.

b. Select the filter and film.

c. Mount the original flat and parallel to the film plane.

d. Adjust the lights for uniform illumination of the original.

e. Focus the camera.

f. Determine the basic exposure and multiply it by the filter factor and the bellows extension factor.

g. Make a trial exposure or more than one exposure.

h. Process the film and make prints.

5-21. How to Copy Transparencies

a. There are two methods of copying transparencies, the indirect method and the direct method.

b. *In the indirect method* you use the transparency as you would use a negative to make a

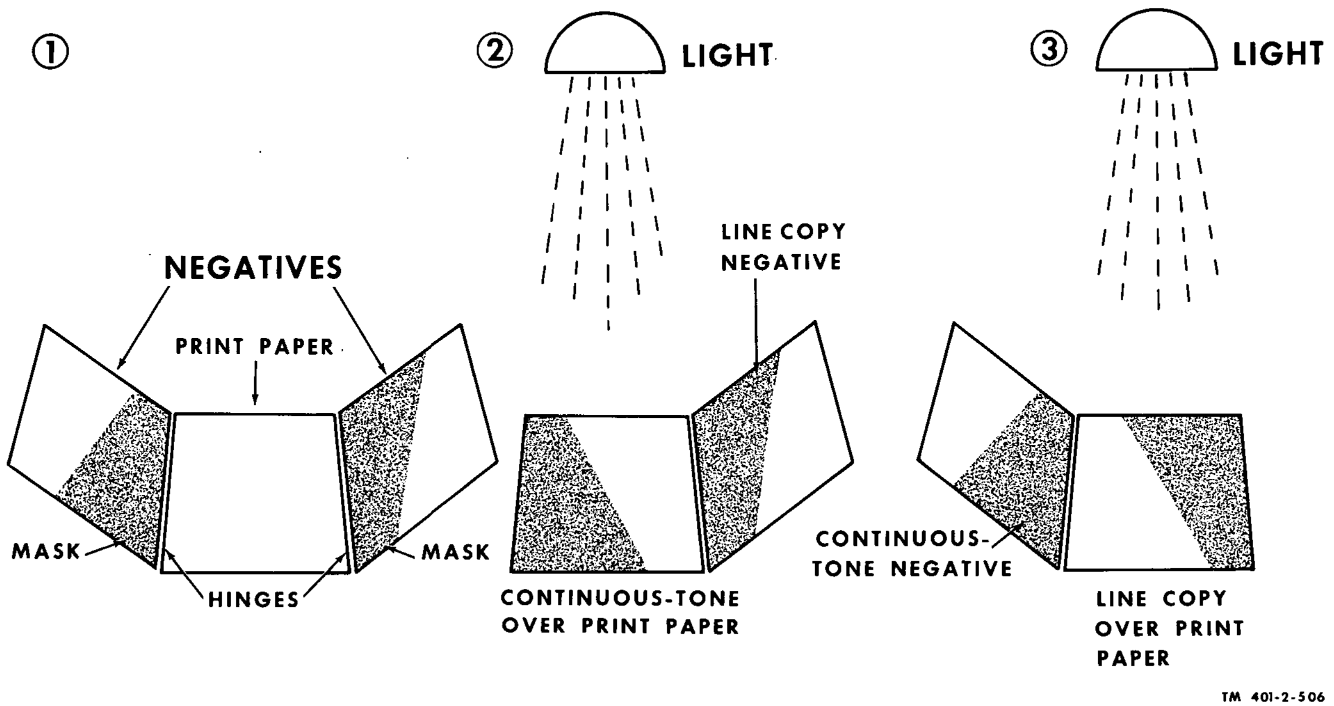


Figure 5-6. Printing with two negatives.

contact or an enlargement print. The print may be made on either film or print paper; in either case the result will be a negative of the transparency. If you use film, you need to repeat the process to get a negative of the negative or a copy of the transparency. Use a commercial or commercial matte film. If you use print paper, then you must photograph the print to get a negative that will be a copy of the transparency.

c. The direct method of copying transparencies uses a film with a solarized emulsion. A solarized emulsion produces the opposite results of a normal emulsion. That is, a solarized emulsion produces clear or light areas where the light strikes the emulsion. Thus, a positive or direct copy can be made with a normal printing process, using the transparency as you would use a negative and the solarized film as print paper.

5–22. Reflex Copying

a. There are many ways you can make direct (scale of 1:1) copies, from using carbon paper to Thermofax. A photographic method of direct copying is called reflex copying. The chief advantages of reflex copying over other forms of direct copying are durability and sharpness of the image. However, direct copy film can produce as sharp or sharper results than reflex paper or film. The scale in reflex copying is 1:1.

b. When the original is translucent (most paper is translucent) and printed on only one side, copy prints are made directly on reflex copy paper by a contact printing process. The original is placed face up on top of the reflex copy paper and exposure is made by shining light through the original (fig. 5–7).

c. When the original is either opaque or printed on both sides an intermediate, "negative," copy must be made. The original and the reflex copy paper are placed face to face, and exposure is made by shining light through the reflex copy paper (B, fig. 5–7). The result of the intermediate step is a mirror image in that words are printed backwards, laterally reversed. By using this "mirror image copy" (after developing) as the original and repeating the process, a normal copy print is produced.

d. Reflex copy paper has an orthochromatic emulsion. The paper should be handled under a series of OA safelight and is developed in about 60 seconds in D72 (one part stock to two parts water) at 68 degrees Fahrenheit.

Section V. SUMMARY AND QUESTIONS

5–23. Summary

a. An original for copying is any chart, photograph, drawing, map, or written document that is to be reproduced.

b. Line copy usually has only two tones and continuous-tone copy has many tones.

c. Scale is the ratio of the original size to the copy size.

d. Copy photography is used to provide copies for distribution; to improve quality by increasing contrast, eliminating stains or smudges, and deemphasizing flaws; and to enlarge or reduce the size.

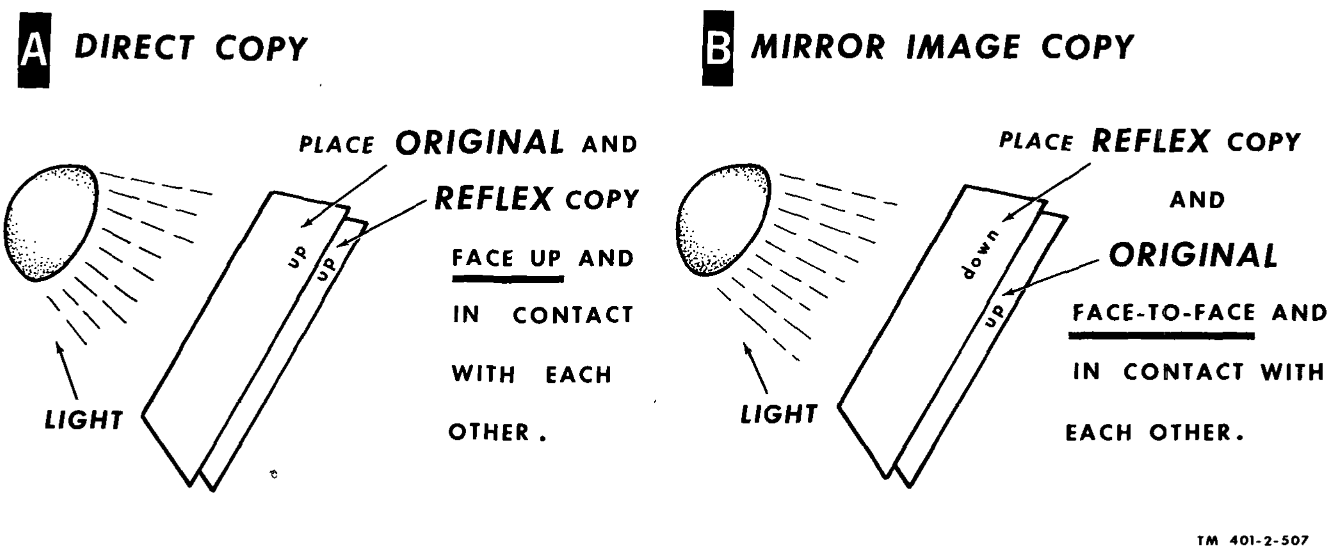


Figure 5–7. Exposure for reflex copying.

e. Still Picture Camera Sets KS-7(1) and KS-7(2) are copy cameras used in a studio, and Still Picture Camera Set KS-4A(1) may be used to copy in the field.

f. Use a slightly longer than normal focal length, anastigmatic lens of medium speed with a small aperture.

g. Use filters for tone correction, to increase contrast, to decrease contrast, and to eliminate transparent stains.

h. Select film according to the type of copying.

i. Mount the original on a copyboard parallel to the film, centered with the optical axis of the lens, upside down, and flat.

j. Back translucent originals with white paper when the print is only on one side and black paper when there is print on both sides.

k. The original must be uniformly illuminated.

l. Place the lights at an angle midway between the camera and the original, at a smaller angle with the camera when the surface is textured, and at a larger angle when the surface is very smooth.

m. Use five times the white card reading for line copy, and use the gray card reading for continuous-tone copy as basic exposure.

n. Multiply the basic exposure by the filter factor and the bellows extension factor.

o. Make a trial negative.

p. Line copy has high contrast and continuous-tone copy has normal contrast.

q. Transparencies can be copied by contact or enlargement printing using film as print paper.

r. Normal reflex copying procedures produce 1:1 reproductions of line copy by a contact printing process.

5-24. Review Questions

a. If the original is a red drawing on a pink background, is it a line or continuous-tone copy?

b. If the original is 32 x 16 inches and scale is 4:1, what is the size of the copy?

c. What focal length lens should be used for copying on 4- x 5-inch film?

d. What filter should you use to blend a green line with a white background?

e. What film should you use to copy a bargraph that has undesirable blue marks on it?

f. What type of backing is used when the original is translucent and has printing on both sides?

g. Describe the shadow method of checking the uniformity of illumination.

h. You are making a 2X enlargement line copy without a filter and the white card reading indicates an exposure of 1/45 second at f/16.

(1) What is the bellows extension factor?

(2) If the best opening is f/22, what exposure time is required for a trial negative?

i. What is the difference in contrast between line copy and continuous-tone copy?

j. When stripping negatives what type of cellophane tape is used on opaque areas? On transparent areas?

5-25. Answers to Review Questions

a. Line copy.

b. 8 x 4 inches.

c. Slightly larger than 6 inches.

d. B filter.

e. Photomechanical thin base pan or process pan film.

f. Black.

g. Hold a pencil perpendicular to the original, eraser end against the original, at the center and each corner of the original. The shadow should be the same in all five instances.

h. (1) The factor equals $(2+1)^2 = 3^2 = 9$.

(2) The exposure time is 0.5 second and is determined as follows:

The white card indication is 1/45 at f/16.

Closing the lens to f/22 cuts the exposure in half; thus we double the time to 2/45 or 1/22.5.

Multiplying by 5 we get a time of 5/22.5 or 1/4.5 for the basic exposure at f/22.

Multiplying by the bellows extension factor (9) we get a time of 9/4.5 or 2.

Thus the estimated exposure is 2 seconds at f/22, and the trial negative should have stepped exposures of ¼ times the estimated exposure of 2 seconds in each step of the trial negative.

i. Line copy has high contrast and continuous-tone copy has normal contrast.

j. Red, Clear.

CHAPTER 6

SELECTED TYPES OF PHOTOGRAPHY

Section I. PHOTOGRAPHING EQUIPMENT

6-1. Reasons for Photographing Equipment

You will photograph equipment mainly for five purposes—training, safety, research, production, and intelligence.

a. For training, equipment photographs provide illustrations for manuals and pamphlets on how to use, maintain, or repair the equipment.

b. For safety, equipment is photographed to analyze the conditions and procedures used in operating the equipment.

c. Equipment photography can aid research in analysis and development of equipment, especially through stop action pictures.

d. In production, equipment photographs aid workers in assembly, aid inspectors in quality control, and aid managers in design of efficient operation.

e. Photographs of enemy and foreign military materiel provide useful intelligence information.

6-2. What Qualities Equipment Photographs Should Have

a. Equipment photographs must be clear, sharp, highly detailed, and technically accurate with a good depth of field and natural perspective. The purpose of equipment photographs is to show objects exactly as they are, not to present a thought, idea, or concept. The picture must look as much like the real object as possible.

b. The viewer must have a clear, unobstructed view of the equipment, and no part of an object should be hidden by shadows. Use flat lighting (1:1) and avoid dramatic lighting. Hot spots or shiny reflections might blot out part of the view. You can avoid or reduce them by properly placing the lights, by using polaroid filters, or by using a dulling spray (a wipe-off aerosol spray that can be applied to the item to be photographed).

c. Because viewers study the equipment through photographs, they must be sharp and have fine detail to prevent any doubt or misrepresentation. Good depth of field is required so that all parts of the equipment are in focus.

d. Equipment photographs must show the true situation as it is, not as it is interpreted. Thus, the pictures must be technically accurate. Do not place the equipment for dramatic effect or eye appeal. You want an undistorted, natural perspective and a truthful representation.

6-3. How to Photograph Equipment

a. The first action is to plan your coverage. With the purpose of the pictures in mind, determine how many exposures and what views you need to completely illustrate the equipment. You might need only one photograph to show size, shape, and controls; however, you may have to take a series to show how the object operates. You are not expected to understand the use and operation of the equipment, so get and use the advice of someone who knows about the equipment.

b. The result of your planning should be a complete list of intended pictures arranged in a logical sequence. It may be a position sequence such as left side, front, right side, and back. Or it might be a time sequence that shows in correct order the motion of a machine during its operation. Or it could be a whole-to-part sequence in which you show the whole object first, then a section, and then an area within the section. Whatever the sequence, it should be logical.

c. Next, select the photographic equipment. To get the required qualities of sharpness and detail, use a fine grain, medium speed, thin base pan film. In the following paragraphs we will discuss in detail the types of equipment photographs and tell why you need different kinds of photographs and photographic equipment.

d. When possible have a technical advisor accompany you when you are photographing equipment. Use his knowledge of the equipment to assure technical accuracy in your photographs. Follow your plan and photograph in the planned sequence, but do not hesitate to make extra exposures or changes as necessary.

6-4. Types of Equipment Photography

We'll divide equipment photography into five categories. One category is groups of equipment —more than one piece of machinery with each piece related to the other. The other four categories are separated according to the size of the equipment, the size defined by the amount of reduction or enlargement in the photograph.

a. A reduction of the equipment size by 10X or more places the equipment photography in the *large* category. That is, when the negative image is 1/10 the size of the object or less then you have large equipment photography. As a rough standard, large means bigger than a man.

b. A reduction of less than 10X is the *small* category. This includes equipment about the size of a breadbox.

c. In the next smaller category we'll include equipment that is not reduced but enlarged up to 10X. A paper clip or perhaps a wristwatch would be included in this type. The formal name for this type is *macrophotography.*

d. The category that includes the smallest type of equipment, equipment that is enlarged 10X or more and includes items that can hardly be seen with the naked eye is called *photomicrography.*

6-5. How to Photograph Groups of Equipment

a. An organization often increases its efficiency and effectiveness by the proper placement of its operational equipment. Different kinds of equipment working together usually require a specific layout, and sometimes equipment must be moved and then replaced exactly as it was. A photographic record is valuable for each of these situations.

b. When you photograph groups of equipment, the individual units are usually not as important as the relative location of each piece. Although each item must be clearly identifiable the equipment's position and placement is what you must show. A single, wide angle exposure of all the equipment may be acceptable, but it should be accompanied by a panoramic or a location sequence. (We will discuss panoramics in paragraphs 6-19 through 6-25.) A location sequence is a series of pictures that shows how the equipment is laid out (fig. 6-1).

c. Photograph a location sequence with a realistic perspective and camera angle. Picture the scene as the observer could actually see it at the site.

d. The image size and perspective should remain constant throughout the main sequence. A piece of equipment that is half the size of another

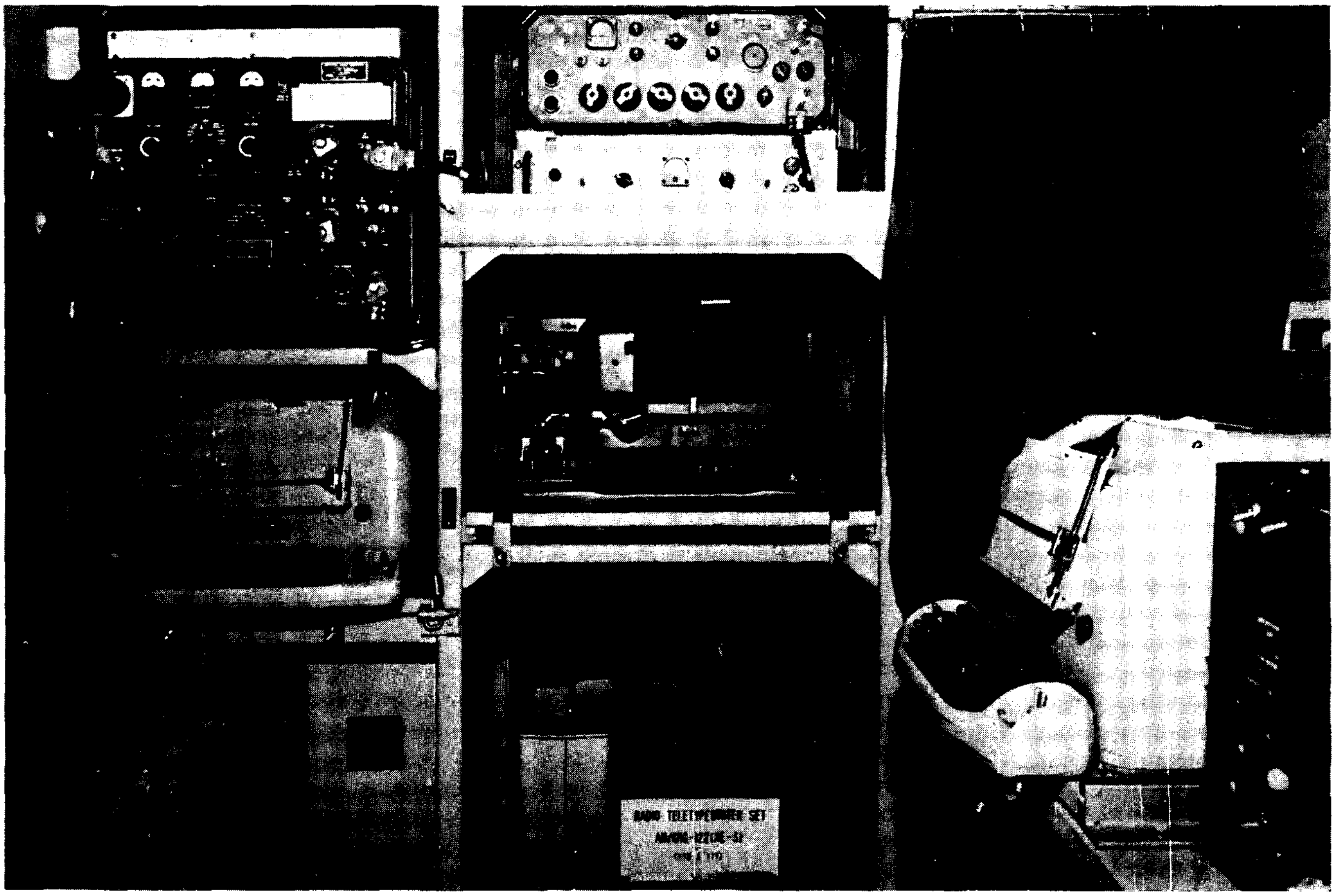


Figure 6-1. A location sequence of teletypewriter equipment.

piece should appear half the size in the pictures even when the items are on different exposures. This does not, of course, exclude you from taking closeups. You should take closeups of important areas, but the closeup should be extra to the main sequence. The area you show in the closeup should be included in a photograph of the main sequence.

e. As a size comparison, include people or a well known object, but do not have the people just standing around—have them doing something such as operating the equipment.

f. Photographing groups of equipment usually means that you must go to the equipment and that you will make a large number of exposures. A 35-mm camera, such as in the Still Picture Camera Set KS–15, is recommended for this purpose.

6–6. How to Photograph Large Equipment

a. A large piece of equipment is usually photographed to illustrate its construction or its operation. To picture the equipment's construction, start with an overall view and follow with a series showing the sections of the equipment. To picture the equipment's operation, make an exposure for each visible step in its operation.

b. The equipment is the only thing that is important, a neutral background is desirable. (When you photograph groups of equipment, background and surroundings are important and must be shown.) Large equipment is often photographed on location, where you have little or no control over the background. If the background is undesirable, use a long focal length lens with a large aperture to put it out of focus.

c. Avoid odd camera angles. Just because it's an impressive piece of equipment, do not try to photographically increase or decrease its size. To show the true size of the equipment, include an operator or a repairman working on the equipment in the picture.

d. Use a camera such as the Still Picture Camera KE–12(2) for large equipment. If you're going to make a large number of exposures, a 35-mm camera will be more convenient, although the quality will be better with a larger format.

6–7. How to Photograph Small Equipment

a. Small pieces of equipment are generally photographed to show shape, size, and construction. Often a single picture is sufficient. To show the components or parts, you may need to make a series of pictures. To show how the equipment is assembled, you can disassemble the unit and then make a series of photographs while the unit is reassembled to show the steps in assembling. An exploded view (fig. 6–2) illustrates both assembly and individual parts by photographing, on one negative, all the disassembled parts arranged to show how they fit together.

b. When you photograph small items you can completely eliminate the background by using a white background without shadows. You can achieve this effect in two ways.

(1) One method is to place the equipment in the center of a large piece of white paper or cloth so that the object is completely surrounded by white. Do not fold or crease the background paper because any abrupt irregularity would tend to create a shadow. First photograph the equipment; then reexpose using only background illumination.

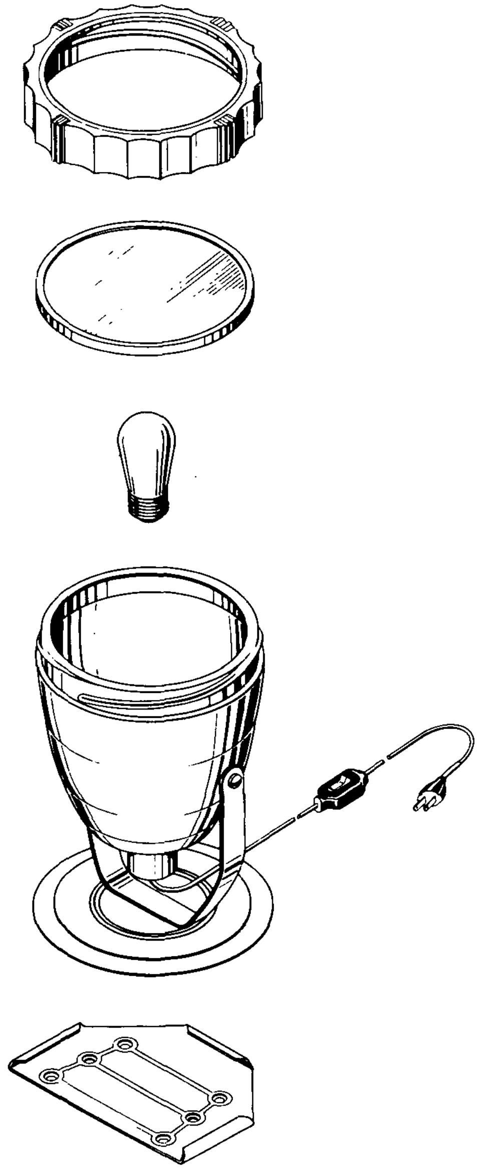


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Figure 6–2. An exploded view.

(2) In another method called the light box method, place the equipment on white, frosted glass or clear glass supported over white paper. The object should be small enough, the glass big enough, and the camera positioned so that the top of the glass forms the entire background. First photograph the equipment using normal procedures; then expose the same negative to diffuse white light coming up through the glass.

c. You may use a pen, a cigarette, or any familiar item for a comparison of size.

d. A view camera with swing adjustments is recommended for small equipment photography.

6–8. Macrophotographing

a. When making macrophotographs in which the image is up to 10 times larger than the object, use a copy camera and the procedures for copying (ch. 5).

b. Indicate the normal size of the equipment by including a familiar item of comparable size in the picture or by stating the amount of magnification.

6–9. Photomicrographing

Photomicrographing is performed through a microscope lens with equipment especially designed for this type of work, such as Camera Set AN/TFH-1. Because of its highly specialized nature and limited application, we will not discuss the details.

6–10. Summary of Equipment Photography

a. Equipment is photographed to aid in training, safety, research, and production.

b. Equipment photographs must be clear, sharp, highly detailed, technically accurate, and undistorted.

c. For equipment photography use a fine grain, medium speed, thin base pan film.

d. Groups of equipment are usually photographed with a 35-mm camera to show the relationship between the individual pieces.

e. In the large equipment category of equipment photography the object is greater than 10 times the size of the negative image, the background is neutral, and a press camera is normally used.

f. In the small equipment category of equipment photography the object is less than 10 times the size of the negative image, the background is eliminated, and a view camera is normally used.

g. In macrophotography the image is up to 10 times larger than the object, and copy procedures are used.

h. In photomicrography the image is more than 10 times larger than the object.

i. Photograph familiar objects with equipment for a size comparison.

6–11. Questions on Equipment Photography

Answer the following review questions and check your responses with the answers in paragraph 6–42.

a. What type of lighting is recommended for equipment photography?

b. What type of film should you use for equipment photography?

c. What type of camera is recommended for photographing an object such as a table model radio? What category of equipment photography is this?

d. What is a light box used for in equipment photography?

e. What is an exploded view?

Section II. LEGAL PHOTOGRAPHY

6–12. Pictures for Detection and Evidence

a. The camera is a useful tool for investigating crime and for legal actions. Pictures are used as permanent records of the scene of a crime or a traffic accident. They are also used to compare and record bullet markings, fingerprints, signatures, and documents. By studying photographs, investigators may gain information that will lead to the solution of a crime, to apprehending criminals, or to stolen goods. And photographs can be used as or to support evidence in court.

b. You can make fingerprints, certain dyes, and some invisible inks show up by using panchromatic film with a yellow filter and ultraviolet lamps.

c. You can use infrared film to read faded documents and charred paper, to bring out old scars and tattoo marks, and to see through grease, grime, and some types of paint.

6–13. A Photograph Alone is not Proof

A photograph by itself is not admissible evidence in a court of law. Someone must attest to the authenticity of the picture. To aid in this, each picture must have a detailed caption. The picture must be carefully protected.

a. The caption must be detailed and exact and should include names, places, dates, times, circumstances, and perhaps measurements as well as photographic data such as focal length, camera angle, and film type. A sketch, even a rough sketch, of the scene will be helpful especially if you make more than one exposure to cover the scene.

b. Strict security procedures are required even when the picture or the information contained in the picture is not classified. The reason for securing even unclassified photographs is to protect their authenticity.

6–14. Legal Photographs are Factual

a. A legal photograph must be clear, sharp, and undistorted. The intent is to picture the facts as they are, not to capture impressions. Do *not* use dramatic lighting and other photographic tricks that improve the eye appeal and stress the concepts of regular photographs.

b. Show scenes in their natural state. Don't add or remove anything. Carefully note any exceptions due to actions of military police or others. To provide a natural view, photograph scenes from eye level with a normal focal length lens.

c. Use a tripod or other solid support to steady the camera so that the pictures are sharp.

6–15. Use a Fine Grain Film

a. A fine grain film is recommended for legal photography because of its capability for small detail and clear enlargement. Enlargement may be necessary for both the investigative and presentation stages of legal action to clearly show

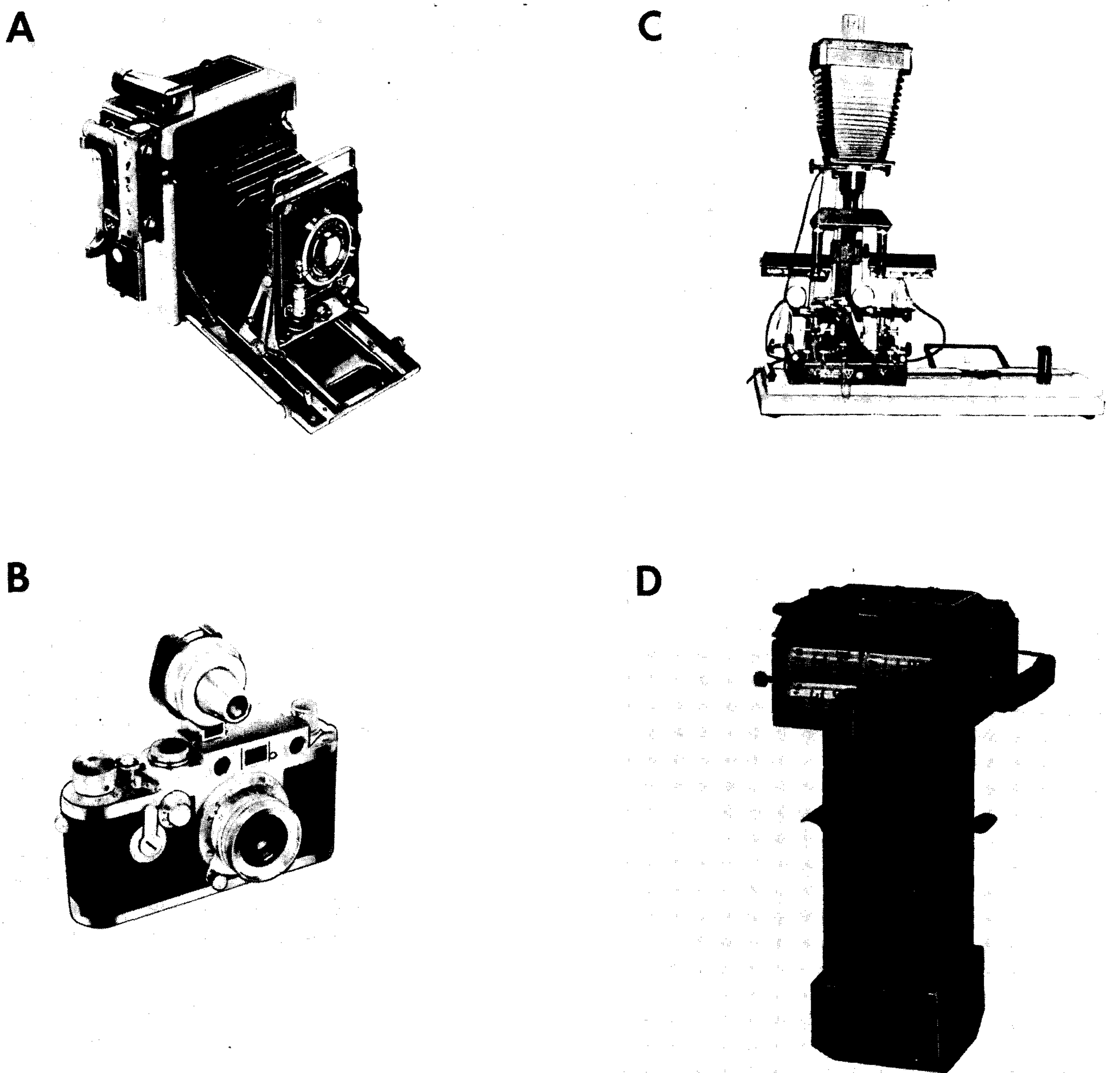

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Figure 6–3. Cameras for legal work.

some small visual fact. Even without enlargement small detail is desirable for sharpness and clarity.

b. Use panchromatic film unless color is an important factor, and then use color film. You should use infrared film when its ability to detect differences in material or to see through substances is required.

6–16. You can use Almost any Camera

a. A general purpose camera such as Still Picture Camera KE–12(2) (A, fig. 6–3) is preferred for legal photography because of its large format and accurate focusing ability.

b. For on-site work where speed is important, many exposures are required, and the lighting conditions are poor, use Still Picture Camera Set KS–15 (B, fig. 6–3). This is a portable, 35-mm camera with a fast lens.

c. Camera Set AN/TFH–1 (C, fig. 6–3) is a photomicrographic unit for routine ballistic studies and comparative studies of fingerprints, signatures, and similar subjects.

d. Identification Still Picture Camera KE–3(1) (D, fig. 6–3) is a fingerprint unit designed to photograph fingerprints, portions of documents, or any other small, flat object at a 1:1 scale. The negative is 2¼ inches by 3¼ inches. The camera's built-in lighting system permits you to photograph subjects on all types of surfaces, including highly reflective backgrounds.

6–17 Summary of Legal Photography

a. Legal photographs should be clear, sharp, and undistorted.

d. Do not change anything when photographing a scene for legal photography.

c. Use fine grain pan film for legal photography.

d. Protect all legal photographs by strict security measures.

e. Your captions for legal photographs must be highly detailed and accurate.

f. You can use infrared film sometimes to make visible that which is normally invisible.

g. Identification Still Picture Camera KE–3 (1), a special copy camera, and Camera Set AN/TFH–1, a photomicrography camera, are specialized units for legal photography.

6–18. Questions on Legal Photography

The answers are in paragraph 6–43.

a. What type of film brings out the writing on charred paper?

b. What accessories should you use with pan film to make some invisible inks show on the photograph?

c. What focal length and camera angle should you normally use to photograph the site of a crime?

d. Why is a fine grain film recommended for legal photography?

e. What type of camera is recommended for routine legal photography?

Section III. PANORAMIC PHOTOGRAPHY

6–19. The Panoramic

a. Usually pictures either have dimensions in the ratio of about 4:5 or they are square. However, sometimes you need a very wide picture to show the whole scene—a panoramic. A road from the air, a river bank from the opposite side of the river, and the surrounding stadium from the center of a baseball field are examples of scenes that you could most effectively show as panoramics.

b. A panoramic is a picture shown one part at a time by being unrolled before the observer, or it's a complete view of an area in every direction.

c. A special panoramic camera produces a continuous image on a roll or a strip of film that is unrolled past a slit as you move the camera. The process is similar to but not exactly the same as using a focal plane shutter. The slit's position is fixed; you move the camera to view each part of the scene; and, the film motion must be in step with the camera motion to properly position each part of the image on the film. In some cameras a rotating prism is used to give the effect of camera motion.

d. You can take panoramic pictures with regular cameras by making part of the picture at a time. To do this you have to make a series of exposures, process the film, and then cut and piece the individual pictures together to form a panoramic (fig. 6–4).

e. Another type of panoramic is made by a lens called a fisheye, which produces a panoramic view on a standard film format. The fisheye is a super wide angle lens. With an angle of view of 180 degrees, the lens sees to both sides, up and down, and forward all at the same time. The resulting scenes are excessively distorted, but with practice you can become accustomed to the unusual view (fig. 6–5).

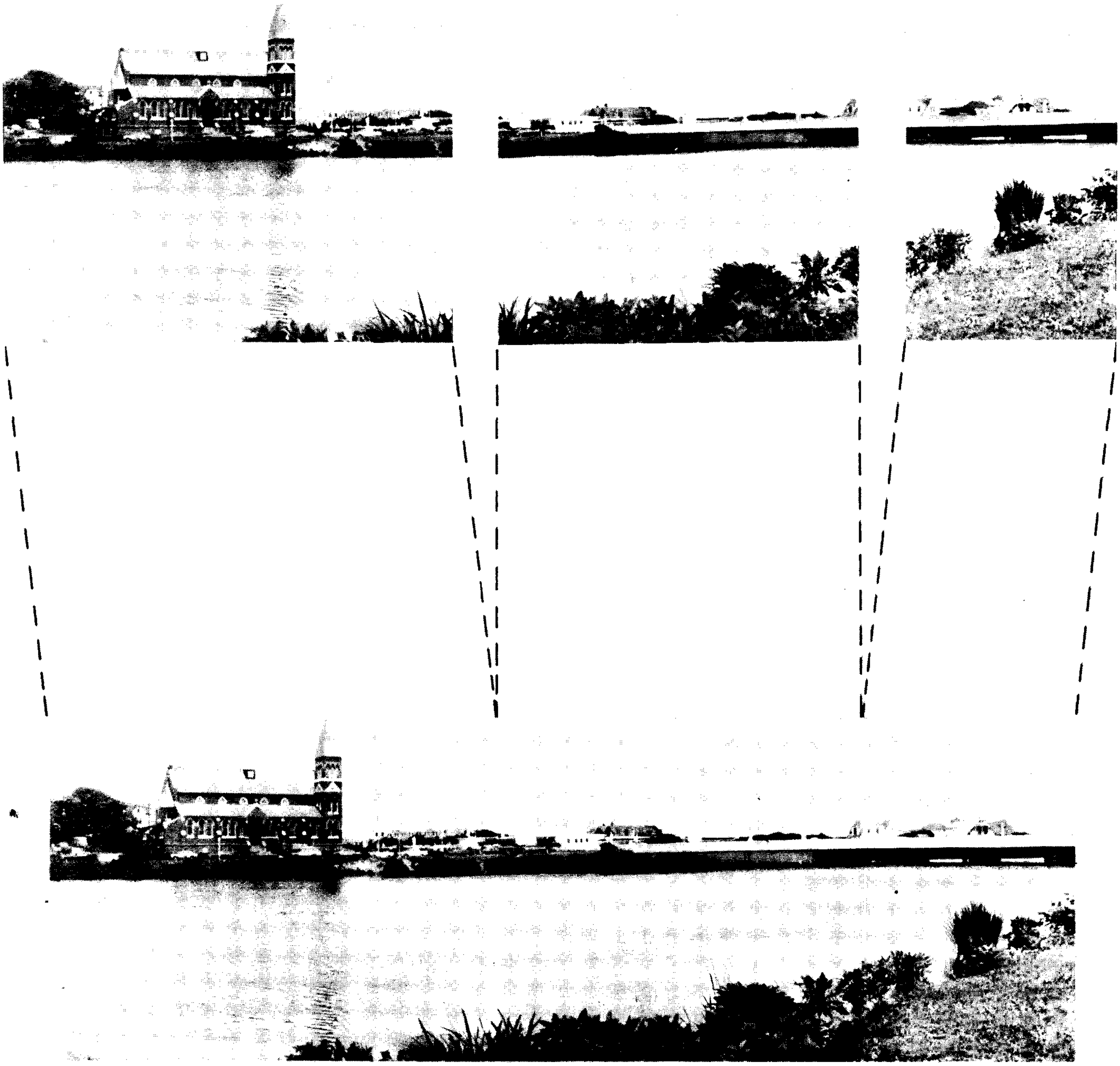

Figure 6-4. Making a panoramic.

6-20. Rotate the Camera for Swing Panoramics

a. To obtain a swing panoramic, the camera stays in one spot, but between exposures you turn it slightly (fig. 6-6). For the first exposure, center the left edge of the scene in the viewfinder and make an exposure. After the first exposure, turn the camera far enough to the right to put the left edge of the scene on the left edge of the viewfinder, and take the second exposure. Thereafter, turn the camera far enough between exposures to move what is in the center portion of the viewfinder scene to the left side of the viewfinder. Continue this process until the right side of the scene to be photographed is centered in the viewfinder, and then make the final exposure.

b. This process results in a series of pictures that overlap 50 percent; that is, 50 percent of the scene on one photograph also appears on the next. You need this overlap to piece the pictures together. Due to the optics involved, the outside portions of the individual pictures cannot be matched as well as the center area. When you piece the panoramic together, cut off the outside

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Figure 6–5. A fisheye view.

(25 percent) edges of each individual print.

c. You measure the size of a swing panoramic in degrees. *For example,* a panoramic that shows everything to the west from a point due south to a point due north would be a 180-degree swing. You make a complete swing, 360 degrees, by rotating the camera all the way around while photographing the area in all directions.

6–21. Move the Camera Sideways for Moving Panoramic

a. In a moving panoramic, always point the camera in the same direction (same compass heading) but move it sideways between exposures (fig. 6–7). As in swing panoramics, the exposures of moving panoramics should overlap 50 percent. You can accomplish the same results with movign panoramics as with the swing type, except that instead of turning the camera you move it sideways.

b. Move the camera in a straight line and parallel to the scene. To assure a good match when piecing together the individual prints, the lens-to-subject distance should remain as constant as possible throughout the sequence, and the camera should neither turn nor tilt.

6–22. Retain Continuity

When producing a panoramic piecemeal, you must fit the individual exposures together so well that no one can tell where one piece ends and the next begins. To do this each piece must look like it belongs in the group. The following are some methods of getting the required continuity:

a. Use a 50-percent overlap.

b. Keep the camera level.

c. Do not turn or move the camera except in the direction of the panoramic.

d. Do not change the scale, use the same focal

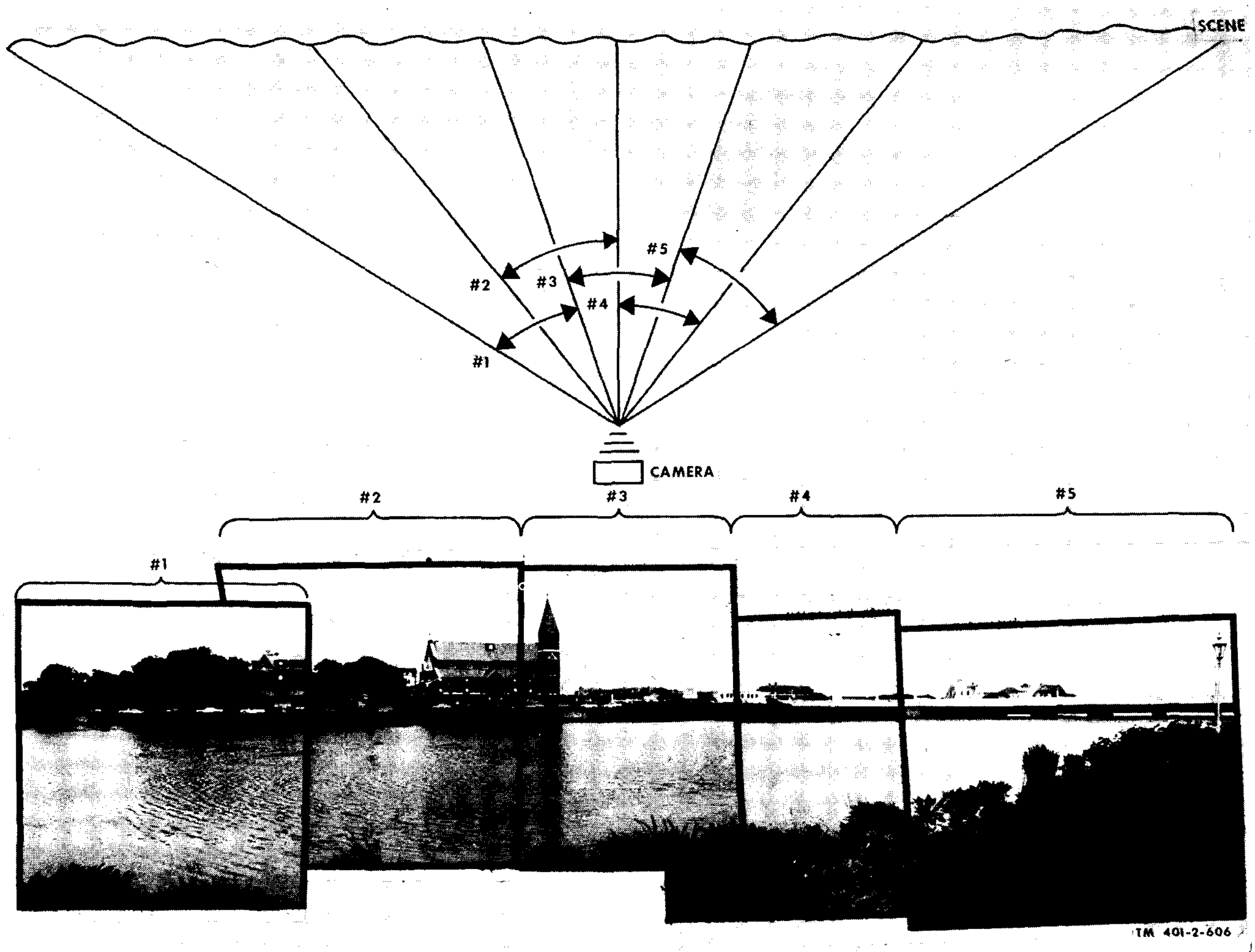

Figure 6–6. A swing panoramic.

length throughout, and keep the lens-to-subject distance as constant as possible.

e. Do not change the focus. Before photographing, study the whole scene and determine a focus setting and a depth of field that will be suitable for all portions of the scene.

f. Use the same type of film throughout.

g. Do not change the f/stop. Avoid changing the exposure, but if you have to, change the shutter speed.

h. Keep the camera steady; use a tripod.

i. If possible, select a time when the illumination is uniform over the entire scene. Clear, cloudless days are best.

j. Use a compass to retain the same heading for each exposure of a moving panoramic.

6–23. Orient Observer With Captions

In your captions, establish the position of the camera and orient the observer of the panoramic by recording—

a. The map coordinates of the camera sites.

b. The compass bearing of the camera for each exposure.

c. The compass bearing of the specific items photographed.

6–24. Summary of Panoramics

a. Panoramics are extra wide views.

b. Special cameras make panoramics by moving the film while the camera moves.

c. You can use regular cameras for panoramics by making a series of overlapping exposures.

d. In swing panoramics rotate the camera but keep it in one spot.

e. In moving panoramics move the camera parallel to the scene.

f. When you make a panoramic from a series of photographs, the exposures should overlap 50 percent.

g. To get good matching when making a panoramic from a series of exposures, you must have continuity throughout the series.

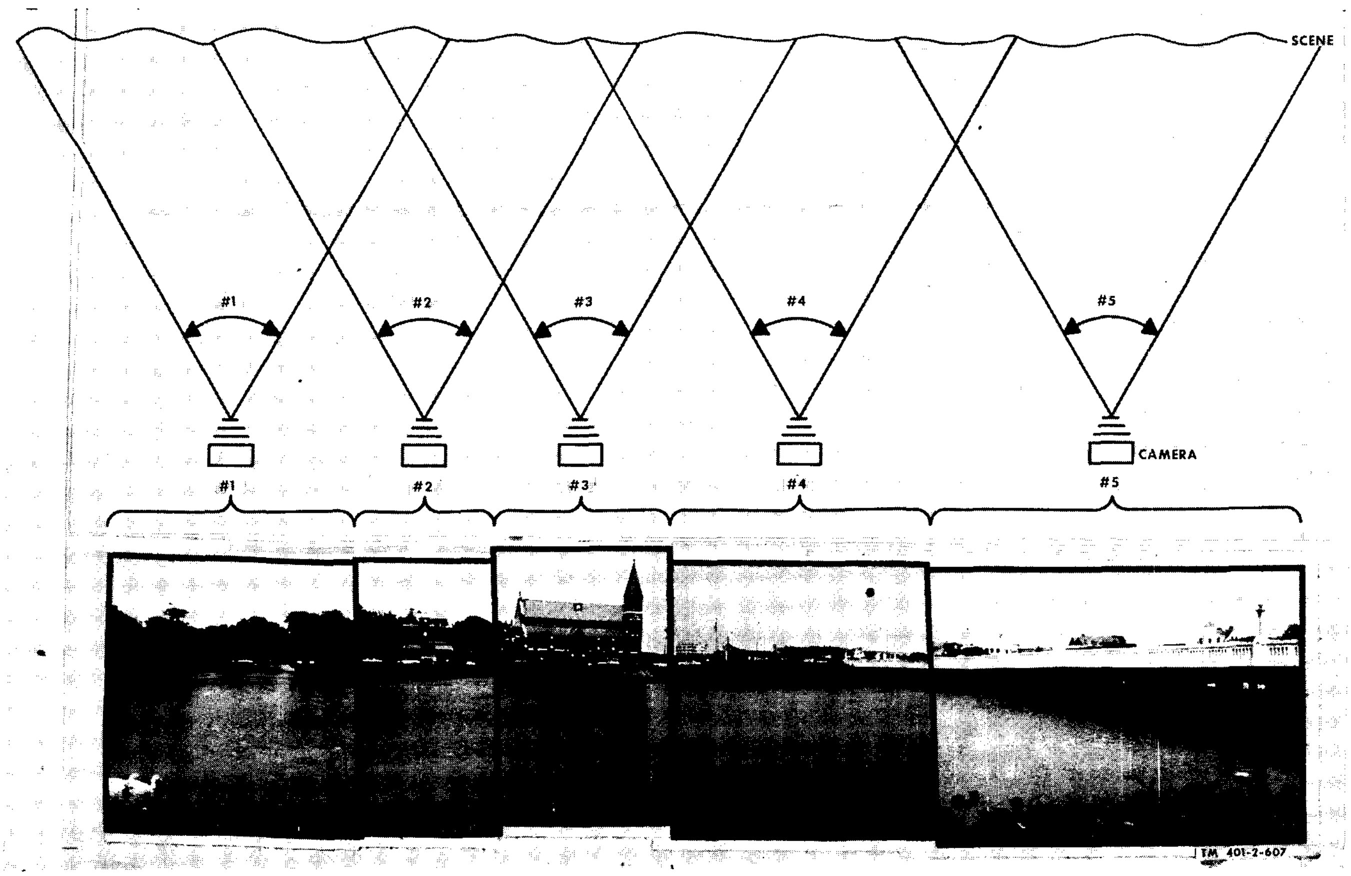

Figure 6–7. A moving panoramic.

6–25. Questions on Panoramic Photography

Answers to these questions are in paragraph 6–44.

a. How much overlap do you use for a series of photographs used to produce a swing panoramic? For a moving panoramic?

b. State six methods of getting continuity throughout a series of exposures for a panoramic.

Section IV. PHOTOGRAPHING IN ADVERSE LIGHT

6–26. What do we Mean by Adverse Light?

a. Usually adverse light means low intensity, but it also includes extreme nonuniform illumination. If you photograph a very bright area and a very dark area in the same exposure, you will lose some detail either in the bright area (overexposure) or the dark area (underexposure). You can often correct nonuniform light by using fill-in lights.

b. Very bright illumination seldom presents any problem in photography because there are many ways you can reduce the effect of light reaching the film. *For example,* you could use neutral density filters, slow speed film, and small apertures. You can control bright shiny spots with polaroid filters.

c. When the natural lighting is of low intensity, the normal thing to do is to use artificial lights such as floodlights and flashbulbs; however, there are times when natural lighting is preferred.

6–27. Pros and Cons of Natural Light

a. On the battlefield, using floodbulbs and floodlights would disclose your position to the enemy, compromising the security and safety of troops. In this situation, photography by natural light is preferred; however, you could use infrared light. Infrared is invisible to the naked eye but not to infrared film. (Infrared photography is the topic of chapter 7.)

b. Bright lights, although desirable to get clear, sharp, detailed pictures, at times will alter the visual appearance and mood of the picture. *For example,* the light from a campfire is uneven but using the even illumination of photographic lights would destroy the campfire feeling. Using the campfire's natural light in this example would make your photograph authentic.

6-28. Low Intensity Requires Increased Exposure Time

a. Exposure time is the product of intensity multiplied by time ($E = I \times t$). Each type of film requires a certain amount of exposure to produce a picture. The exposure latitude of the film is how much over and under the perfect amount of exposure you can go and still get a good picture. To get the correct exposure as the light intensity gets lower, you must increase exposure time.

b. Slow shutter speeds are used for low intensity light. By slowing down the shutter speed you increase the exposure time, allowing the light to strike the film for a longer than normal time. Shutter speeds of 1/10 of a second to a whole second are not uncommon for normal indoor lights, and exposures in moonlight may run many minutes.

c. Slow shutter speed is not the only way to adjust for low intensity light. If you open the lens aperture wider, you increase the amount of light that gets to the film. Thus, widening the aperture increases the intensity in the exposure formula. So for low level light you will use f-numbers: 1.4, 2, 2.8, and so on.

d. You can also compensate for low intensity light by using a high speed film, thereby decreasing the need for large amounts of exposure. Fast film requires less exposure to light than slow film to produce a good picture. The speed of a film is stated by its ASA or one of the other speed ratings. The higher the ASA rating the faster the film.

6-29. How to Determine Exposure

a. The calculation of exposure is discussed in chapter 6 of TM 11-401-1. Here we'll only stress some points on exposure for adverse lighting.

b. Use an exposure meter whenever possible. Without an exposure meter you'll have to rely on experience or guesswork. When guessing the exposure it's good practice to make three exposures —one at the guess; one, eight times the guess; and, one, 1/8 of the guess.

c. The following chart lists some examples that may help you in estimating exposure. Situations vary too much to give exact figures, but the examples are typical of Tri-X film with frontal lighting.

Exposure Examples

Situation	Exposure
(1) Classroom, kitchen, office, store, or other well lit room.	1/25 sec. at f/4
(2) Museum, living room, dayroom, or other room lit for comfortable viewing but not for reading.	1/10 sec. at f/2.8
(3) A stage with stage lights.	1/30 sec., wide open
(4) Moonlight	15 minutes for each 1/100 second in sunlight.
(5) Bright firelight	1/50 sec. at f/5.6
(6) Fireworks, lighting, and firebombs at night.	f/8 or f/11. Aim and secure camera. Open shutter before burst and leave open until after the burst.
(7) Electric signs	1/100 sec. at f/4
(8) Scenes that include lights.	Underexpose the scene in daylight or with floodlights and reexpose after dark to record normal lights.

6-30. Four Difficulties of Adverse Light Photography

Four difficulties seem inborn in adverse light photography, although they can be a problem in any type of photography. They are blurred image, shallow depth of field, extreme contrast, and low density.

a. A blurred image is the result of motion of either the subject or the camera. Due to the slow shutter speed required with low intensity illumination, there is more time than usual for motion to occur during the exposure.

b. The shallow depth of field in adverse light photography is due to using large apertures.

c. Extreme contrast is the result of uneven lighting conditions.

d. Low density means the lack of blackness or opaqueness of the negatives. Since the amount of blackness is directly related to the amount of light that hits the film, the low intensity of adverse light results in a low density negative.

e. You can minimize these effects by using good photographic practices and by compromising.

6-31. Good Practices Minimize Difficulties

a. You can reduce image blur due to camera motion by holding the camera steady. Use a stationary object, preferably a tripod, to support the camera. If you must hold the camera in your hands use a neck strap, keep your elbows tight against your body. Stop breathing just before and during the exposure, and brace your body by leaning against a wall or by spreading and tensing your legs.

b. You can minimize blur due to both camera and subject motion by using the fastest possible shutter speeds.

c. To get maximum depth of field use the smallest aperture that the light conditions will allow.

d. To reduce contrast use a low contrast film and use a flashbulb to fill in the shadows; or, when cut film is used, double the exposure and decrease the time of development.

e. To increase density you need more light reaching the film or a faster film.

6-32. Minimize Bad Effects by Compromise

a. Minimizing bad effects by compromise means lessening some quality to improve some other quality, so that the overall result will be better. In other words, you'll trade a bad quality for one that's not so bad. In a trade like this you have to be careful to see that you get the better end of the deal.

b. Typical of compromise is the selection of shutter speed and f/stop. You can use a faster shutter speed (get less blur) if you use a large aperture (smaller depth of field). On the other hand, a smaller aperture (greater depth of field) forces you to use a slower shutter speed (more chance of blur).

c. Films with high ASA ratings require less light, so by using fast films you can increase the shutter speed or reduce the aperture. Fast films generally have a coarser grain, which is not too important with contact prints but may be bad if you want fine detail or enlargements.

d. Forced development can be used to remove some image blur but it will also increase the highlights and the graininess.

e. You can overcome extreme contrast by overexposing and underdeveloping. The procedure permits more chance for image blur in the photograph and results in a loss of sharpness with an increase in graininess.

f. A drastic measure that will reduce the required exposure is to persensitize the film. The techniques vary, but one, hypersensitization by preexposure, reduces the contrast and increases the fog in the picture.

6-33. Summary of Adverse Light Photography

a. Adverse light includes both low intensity and nonuniform illumination.

b. Natural light, although sometimes difficult to use in photography, often provides military security and improves the visual value of a photograph.

c. Use slow shutter speeds, large lens apertures, and fast films to photograph under low intensity light.

d. The best method of determining the proper exposure is to use an exposure meter.

e. Adverse light photography demands that you use good photographic practices.

f. In adverse light photography you may have to accept a compromise between the best of several bad qualities.

6-34. Questions on Adverse Light Photography

Answers are in paragraph 6-45.

a. What shutter speeds, what apertures, and what types of film are used for low intensity illumination?

b. What shutter speed and f/stop should you use to make an exposure in a dayroom under natural frontal lighting with Tri-X film?

c. Why is image blur common in adverse light photography?

d. Why is shallow depth of field common in adverse light photography?

e. What kind of an object should you use to prevent image blur?

f. What is usually the disadvantage of using the faster films?

Section V. ACTION IN STILL PHOTOGRAPHY

6-35. Composition for Action

a. You can show motion on still photographs, motion that is real or posed. To get the feeling of motion in a still picture, the viewer must know what occurred the second before the exposure or what will occur the next second. Place your subjects in positions that suggest that motion is about to happen, is happening, or has just finished. A complete action can be divided into three parts—preaction, when the subject is getting ready; midaction, when the subject is in motion and cannot turn back; and postaction, when the subject has completed the motion and is regaining equilibrium. As an illustration of these stages let's look at a man hitting a golf ball (fig. 6-8).

(1) *Preaction.* In A of figure 6-8 the man is addressing the ball. His arms and body are straight.

(2) *Midaction.* In B, the man's arms are cocked, his body is twisting to the side and back, and he appears just about ready to hit the ball.

(3) *Postaction.* In C, the man has hit the

ball, his arms are outstretched, and his body has twisted around forward.

b. The best action photographs are taken at the time of change from preaction to midaction to postaction. The first change, the *point of tension,* is the beginning of the motion. It is the time when the greatest stress and strain is applied. The effort of putting things in motion is evident in the tension of the subject's muscles and his facial expressions.

c. The time of the change from midaction to postaction is the *point of release.* At the point of release the effort is reversed. While momentum is carrying the motion forward, the stress and strain is being applied as a break. The effort by the subject at the points of tension and release provides the greatest expression of motion for a still photograph.

d. Midaction is also a good time for photographing if the motion is obvious. Catch the subject in a position that would be impossible without motion, *for example,* when the subject is in midair or is leaning over so far he would surely fall down if it were not for his motion, or even when he is falling down.

e. The subject need not stand still for posed action pictures. He can rehearse and then move through the actions as you photograph.

f. Although posed action provides time for planning and composition, you record the truest expression by photographing the real thing at the scene while it's happening.

g. You can also add action to your photocomposition by using diagonal lines (leaning bodies), blurring part of the subject (hands or feet) as though they were moving too fast for the camera (A, fig. 6-9), and blurring or placing the background out of focus as though you're moving with the subject (B, fig. 6-9).

6-36. Panning for Action

a. The technique used to blur the background while getting a sharp image of a moving object is called panning. To pan, you move the camera in step with the moving object so that the object is standing still with respect to the camera and the background or other stationary objects are in apparent motion.

b. Use the following procedure when panning:

(1) Get a firm grip on the camera.

(2) Plant your feet about 18 inches apart for a firm foundation.

(3) Begin your motion before the exposure.

(4) Swing the camera with the object so that the object remains centered in your viewfinder.

(5) Move the entire top of your body in swinging the camera.

(6) Use a smooth, steady motion.

(7) Make the exposure during your motion.

(8) Keep moving for a short time after the exposure.

c. The reason you start moving the camera before the exposure, and keep it moving until after the exposure, is to assure a smooth steady motion during the exposure.

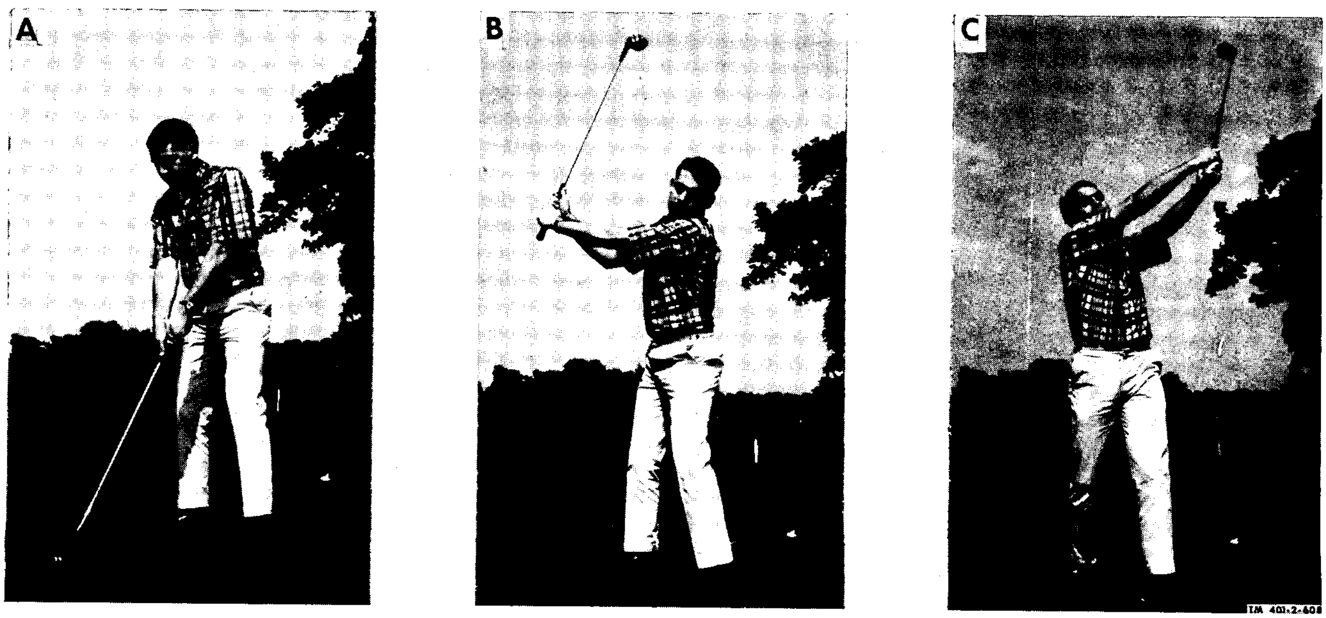

Figure 6-8. Parts of action.

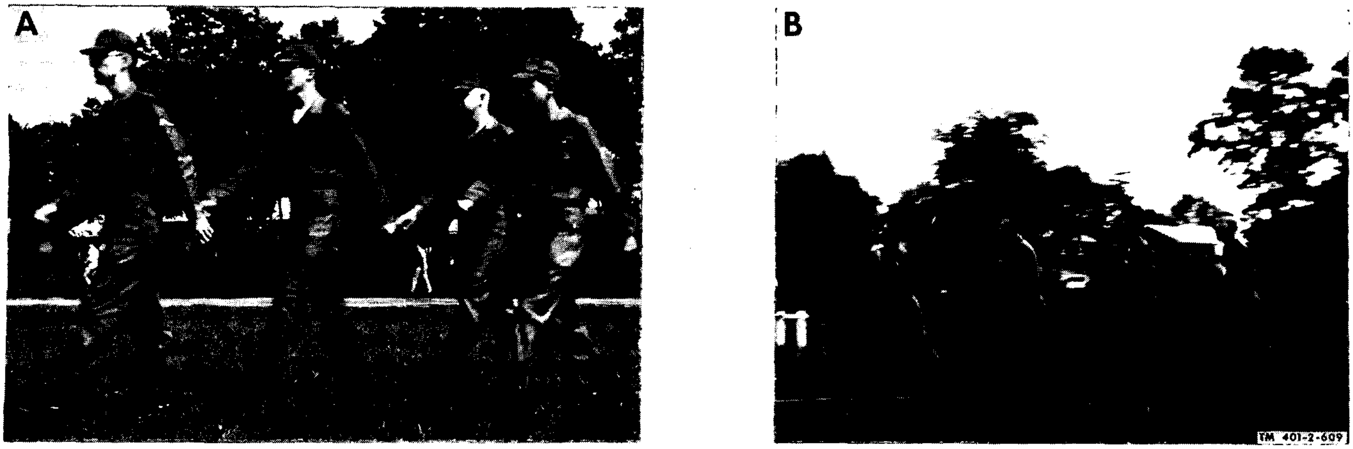

Figure 6–9. Blurring for action.

6–37. Stop Action Photographs

a. Panning allows you to get a clear, sharp picture of a moving object; however, the background is blurred. To get both the moving and stationary objects in sharp detail on the same still picture you have to stop the action. Photographically, you stop the action by using an exposure time so short that the moving object hardly moves at all during the exposure.

b. To take a good stop action photograph, you must have knowledge of the subject and the action so that you can visualize what will happen and plan ahead. You must be alert to follow the action and make the exposure at exactly the right moment, and you must quickly and automatically adjust and operate your camera.

6–38. Bright Light for Stop Action

a. You take stop action photographs with very fast shutter speeds so there is almost no time for motion during the exposure. Usually you increase the lens opening to compensate for an increase in shutter speed, but with stop action you often need the depth of field of small apertures. So opening up the lens is not always the best way to get the proper stop action exposure. When you operate with fast shutter speeds and large f-numbers, you must use fast film and bright lights to get sufficient exposure. For stop action, you need artificial lights, flood or flash, except in brilliant sunlight.

b. You can use flashbulbs to stop action for a scene too dark to record on film without additional illumination. Leave the shutter open, and the exposure time will be the duration of the flash. Speed lamps or electronic flash units have very high intensity illumination and the flash may be as short as 1/10,000 of a second. Use moderate shutter speeds in conjunction with flash units to get the effect of high shutter speeds when the scene is moderately illuminated (ch. 8).

6–39. Motion Versus Shutter Speed

a. Your principal objective in taking a stop action photograph is to reduce or stop image motion during the exposure. It is logical that the faster an object is moving the faster the shutter speed has to be to stop the action. Although it's important, the object's speed is not the only factor to consider.

b. Two big factors are how critically the picture will be viewed and how much the picture will be enlarged. In general, the image should move no more than twice the diameter of the circle of confusion.

c. You must increase the shutter speed to stop the action—

(1) As the object's speed increases.

(2) The nearer the object is to the camera. When the motion is parallel to the film, the ratio of object motion to image motion is proportional to the ratio of lens-to-object distance to the focal length, just as is the ratio of object size to image size.

$$\frac{\text{object motion}}{\text{image motion}} = \frac{\text{lens-to-object distance}}{\text{focal length}} = \frac{\text{object size}}{\text{image size}}$$

(3) As the focal length of the lens increases. Enlarging the image enlarges the image motion.

(4) As the direction of the object's motion becomes more parallel to the film. Let's illustrate this point in detail (*d* below).

d. When an object is moving across your field of view at 90 degrees to the optical axis of the lens, the image moves faster than when the object is traveling along a line that makes a smaller angle with the optical axis. The smaller the angle of motion (fig. 6-10), the slower the image motion. An object moving toward or away from the camera along the optical axis (a zero degree angle of motion) does not change its position on the film, but it does change image size. The image grows bigger as the object approaches, and the image shrinks as the object recedes.

e. Table 6-I is a guide to selecting the shutter speed for stop action. You may use faster speeds but not slower ones. The table is for normal focal lengths; you should increase the shutter speed for long focal length lenses.

6-40. Summary of Action Photography

a. Apparent action increases the eye appeal of still photographs.

b. An action can be broken down into three parts: preaction, midaction, and postaction.

c. The point of tension is the change from preaction to midaction.

d. The point of release is the change from midaction to postaction.

e. You show action in still photographs by tension and subject position, by blurring part of the subject, by blurring the background, and by using diagonal lines.

f. Planning provides a sharp image of the moving object while blurring the background.

g. Stop action requires fast shutter speeds, fast film, and bright lights.

h. Shutter speed depends on the object's speed, distance, and angle of motion.

Table 6-I. Shutter Speeds for Stop Action

		Lens-to-object distance (feet)								
		25			50			100		
Object speed	Examples \ Angle of motion	0	45	90	0	45	90	0	45	90
5-10 mph	Parades, pedestrians, slow moving vehicles.	1/100	1/200	1/400	1/50	1/100	1/200	1/25	1/50	1/100
20-30 mph	Sports, slow moving boats, parachutists.	1/200	1/400	1/800	1/100	1/200	1/400	1/50	1/100	1/200
60-up mph	Fast vehicle, airplanes, PT boat	1/500	1/1000	1/2000	1/200	1/400	1/800	1/100	1/200	1/400

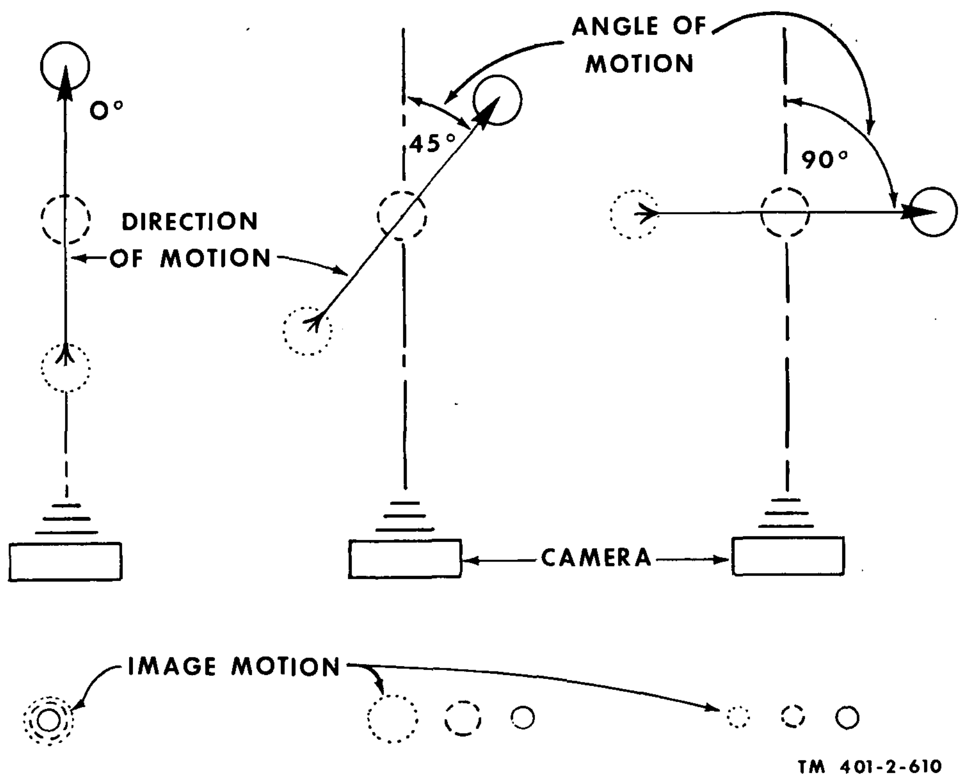

Figure 6-10. Angle of motion.

6–41. Questions on Action Photography

Answers are in paragraph 6–46.

a. What is the point of tension?

b. What is the point of release?

c. When do you start and stop panning the camera for a sharp image of a moving object?

d. With respect to the film, in what direction is an object moving when the angle of motion is—

(1) 0 degrees?

(2) 90 degrees?

e. What shutter speed should you use for a stop action photograph of a tank moving directly at the camera about 50 feet away? Use table 6–I.

6–42. Answers to Equipment Photography Questions in Paragraph 6–11

a. Flat, a 1:1 lighting ratio.

b. Fine grain, medium speed, thin base pan film.

c. A view camera. Small equipment photography.

d. To eliminate the background (produce a clean white background).

e. A view that shows each part of a piece of equipment separately but arranged to indicate how they all fit together.

6–43. Answers to Legal Photography Questions in Paragraph 6–18

a. Infrared.

b. Yellow filter and ultraviolet lamps.

c. Normal focal length and eye level.

d. For small detail and capability of enlargement.

e. Press.

6–44. Answers to Panoramic Photography Questions in Paragraph 6–25

a. 50 percent. 50 percent.

b. (Any six in any order.)

Keep camera level and steady.

Do not turn or move camera in a direction other than that of the panoramic.

Do not change scale, focal length, lens-to-subject distance, focus, film, and f/stop.

Use a compass.

Photograph when illumination is even.

6–45. Answers to Adverse Light Photography Questions in Paragraph 6–34

a. Slow shutter speed, large apertures, fast films.

b. 1/10 second at f/2.8.

c. Because of slow shutter speeds.

d. Because of large apertures.

e. A stationary object, tripod, or neck strap.

f. Coarse grain.

6–46. Answers to Questions on Action Photography in Paragraph 6–43

a. The change from preaction to midaction.

b. The change from midaction to postaction.

c. Start before and stop after the exposure.

d. (1) Directly toward or away from the film.

(2) Parallel to the film.

e. 1/100 second.

CHAPTER 7

INFRARED PHOTOGRAPHY

7-1. Introductory Information

a. The visible spectrum, those wavelengths of radiation that we can see, is very narrow when compared to the complete spectrum of all radiation. Visible radiations (light) have wavelengths between 400 and 700 millimicrons. Our eyes see these different wavelengths as different colors. The low end of the spectrum looks blue, and we see all the colors of the rainbow as we increase the wavelength up to red at the high end of the spectrum.

b. The radiations above and below the visible spectrum also have color names even though we cannot see these radiations. Just below 400 millimicrons the radiation is called ultraviolet, and above 700 millimicrons (beyond visible red) is INFRARED radiation. Since infrared is invisible, a room that looks pitch black to us may actually be brilliantly illuminated with infrared "light." Using a special film to make a black and white picture of the infrared, we can see things in a different light—infrared light. Let's find out how you can capture this infrared light on film.

7-2. Infrared Film Sees in the Dark

a. There are many devices, such as night surveillance systems (which illuminate a scene with infrared) and thermal detectors, that can convert the invisible infrared radiation into an image that you and I can see. Most of these devices use only a small part of the infrared spectrum, which includes wavelengths from 0.7 microns to about 100 microns. Infrared film is a special type of film that is sensitive to infrared radiation. It uses only the infrared that is just beyond the red or about 0.70 to 0.98 microns (fig. 7-1). At longer wavelengths the sensitivity of the film, the opaqueness of glass, and change in focal length create problems in recording a clear, sharp picture on film.

b. The military finds infrared film especially useful because infrared film can produce a black and white picture *without* the brilliant illumination standard photography requires. This prevents the enemy from spotting troops and locating targets by the light needed to take a standard photograph. However, safety in combat is not the only use of infrared photography as you'll see later in this text.

c. No film can record images of objects in total darkness. Infrared film requires just as much illumination as panchromatic film; the difference is the type of light it requires. Although all objects radiate some infrared the amount is generally not sufficient for photography, so you will need to supply additional infrared light. Fortunately, since almost all sources of visible light also radiate a high degree of infrared you can use available light. In addition, you can use infrared or blackout flashbulbs and flares, which produce illumination for infrared photography with almost no visible light.

7-3. Infrared Pictures are Different

a. As we have already stated, a scene that looks dark to the eye may be clear and bright on an infrared print. From this you may suspect that there are other differences on infrared prints. Well—there are. It's the differences that make this type of photography useful. In the following paragraphs we'll discuss the differences to show you when and where to use infrared film.

b. First, let's just mention that color is meaningless because infrared is invisible; it has no color. The negatives of infrared film have varying degrees of opaqueness, and the prints have varying shades of gray according to the brightness in infrared of the objects you photograph.

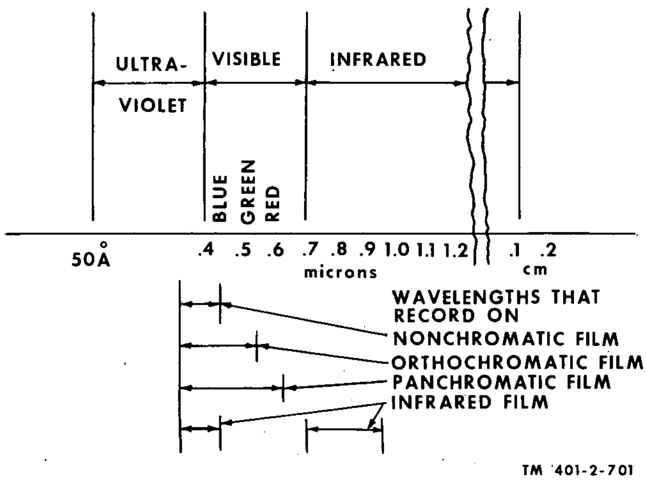

Figure 7-1. The spectrum.

7–4. Some Opaque Objects Appear Transparent

a. Infrared radiation passes through some objects that are opaque to visible radiation. *For example,* human skin is translucent to infrared, so the radiation passes through the skin and may show the veins clearly on infrared photographs. This feature makes the film a poor choice for portraits but a good aid to medicine. Doctors use infrared photography to diagnose and evaluate skin disorders and treatments much the same as they use X-rays for diagnosing internal ailments. Part A of figure 7–2 compares an infrared portrait to a standard portrait in part B.

b. Some inks, dyes, and paints are transparent to infrared radiation; thus, it is possible to photograph through them. For instance, take a piece of copy that a censor has marked. If you photograph it with infrared, you may be able to read the printing under the marks, depending on the types of ink used. You might also be able to read a serial number on a piece of equipment even though the number was covered over with paint. And, sometimes you can even detect forgeries or alterations of documents because different inks or paints may photograph differently with infrared film even though they look alike. However, you can't always photograph something underneath paint or ink. The covering must be transparent and the object must be opaque to infrared. If both are transparent nothing shows, and if the covering is opaque, you cannot see through it.

7–5. Look-Alike Objects may Reflect Infrared Differently

a. Infrared photographs may show a distinction between items that visually reflect the same amount and color of light because their reflection of infrared is different. We identify objects as red or blue because they reflect more red or blue light than other colors. Just as red and blue objects reflect more red and blue, some things reflect more infrared.

b. In general, warm or living objects reflect more infrared than visible light, while cold or dead objects reflect less. Remember the phrase "red hot" to remember that *hot* items generally reflect more infr*ared.* Actually, heat and infrared are very closely related.

c. During the growing season, trees, crops, and grasslands appear lighter on prints made from infrared film than on prints made from panchromatic film. An expert photographic interpreter can tell the type of tree, earth, and other land covers by comparing the infrared picture to the same scene made from panchromatic film. For example, he can detect a difference between grass growing in dry, sandy soil and that growing in wet, muddy soil. This type of information may aid in planning troop movements.

d. Live foliage appears brighter on infrared prints than dead foliage. You can detect camouflage made of dead foliage on an infrared print as long as there are no infrared reflecting dyes in the camouflage. Since the enemy also knows the photographic effects of infrared, he will no doubt carefully prepare his camouflage of permanent installations so that you are unlikely to detect it in an infrared photograph. But you may be able to readily detect makeshift or temporary covers by taking an infrared photograph. For your own protection, remember that freshly cut branches and leaves are most likely to fool infrared detectors.

e. Cold, inanimate objects such as deserts, stone buildings, dead trees, fields covered with snow, and shallow water reflect less infrared than visible light. They appear darker on prints from infrared film than on prints from panchromatic film.

f. A trained eye can detect differences in dyes, hair, or fibers by infrared photography because of the variation in the amount of infrared these items reflect. A person trained in criminal investigation by infrared techniques can actually identify a specific fiber.

g. Most of the uses of infrared we've mentioned so far require a trained observer and are not obvious to most people. However, there are some obvious effects of infrared reflection. *For example,* the sky in an infrared picture appears black, so scenes taken during the day look like night in infrared. Some invisible inks show clearly on an infrared print, and writing on charred or old paper is more legible on an infrared print (C, fig 7–2). As you have gathered, you can use infrared to see the invisible.

7–6. Infrared Sees More Clearly Than Other Film

a. In some instances when you photograph a scene with infrared film it looks much clearer than with other types of film. For example, atmospheric haze is blue and ultraviolet light coming out of the air. The haze exposes and records on most types of film as an overall, dull gray that masks the details of a scene. But on infrared film, the haze doesn't show and the details show up clearly. You get more effect from filters used to prevent the haze light from reaching infrared film. However, infrared film does *not* effectively penetrate dust, smoke, fog, or rain.

b. Another example is the ability of infrared to penetrate water. This capability is directly related to the depth of the water. If you take vertical infrared photographs of water, they accurately record submerged items in water up to about 20 feet deep. The Army uses information obtained from infrared photographs of shorelines to aid in planning landing operations.

7-7. Infrared Photographs do not Look Natural

a. We do not see infrared radiation and pictures made with infrared light do not look normal. Some things look lighter in an infrared photograph, some look darker, and we see things that we ordinarily would not.

b. Infrared is not a good medium for photographing people. If you do use infrared film to photograph a person, his veins show (but not arteries) as though the skin were removed. His lips appear very light, his eyes very black, his glasses opaque. In A of figure 7-2, the model appears to need a shave. Actually the film has recorded the heat from the capillaries that are close to the surface of his face.

c. When you photograph landscapes with infrared film, the sky appears black but clouds show up white. Grass and leaves are very light and look more like snow. Although snow appears light, it is not as white on infrared film as it is on panchromatic film. Distant details show up clearly, making infrared film useful for reconnaissance (fig. 7-3).

d. You can use infrared film to take night scenes during the day. The reason—daylight scenes appear dark like night on infrared film. The sky appears black and the grass looks moonlit, while buildings and shadows are very dark.

e. Summarizing the effects of infrared film, we can say that because the resulting pictures are unnatural, infrared film is a poor choice for portraits, group photographs, snapshots, and photographs intended for public or general information. Infrared is more useful for scientific, technical, and tactical photographs. Before discussing the techniques for using infrared film, let's review its uses.

7-8. Summary of the Uses of Infrared

The following chart lists some examples of the uses of infrared film. The list is not all inclusive and need not limit the uses of infrared film.

7-9. Infrared Film

a. Infrared film is much the same as any other type of film. It comes in many sizes to fit many cameras. It must be exposed, developed, and fixed to produce a negative. You should handle it with the same care and store it in a dry, cool, dark place as you do other film.

b. There are two main characteristics that make infrared film different from other types: (1) the film is sensitive to radiation that the eye cannot see, and (2) the focal length of a lens is longer for infrared light than for visible light. The following paragraphs will discuss how the differences in infrared film affect the production of photographs and what you should do when you use infrared film. Let's start at the beginning of the process by selecting the proper camera and continue through each stage of the operation down to the final print.

7-10. All Cameras are not Suitable

a. The camera you use for infrared photographs must be light tight. That is, light must not leak in around the bellows or the body of the camera and fog the film. Some cameras, especially older models, are not light tight. You may have used a certain camera before without any trouble and you may not be able to see any leaks,

Type of photography	Use	Characteristic of infrared utilized
1. Combat	For safety	Invisible radiation
2. Investigation	To read through paint or ink	Difference in transparency
	To detect forgeries	Difference in transparency
	To identify dyes, hair, or fiber	Difference in reflectability
	To read invisible writing	Difference in reflectability
	To read charred papers	Difference in reflectability
3. Medical	Diagnose and evaluate treatment of skin conditions	Difference in transparency
4. Reconnaissance	To get clear distant details	Penetrability
	To indicate depth of water	Penetrability
	To detect camouflage	Difference in reflectability
	To evaluate terrain	Difference in reflectability
5. Special effects	To make day look like night on prints	Difference in reflectability

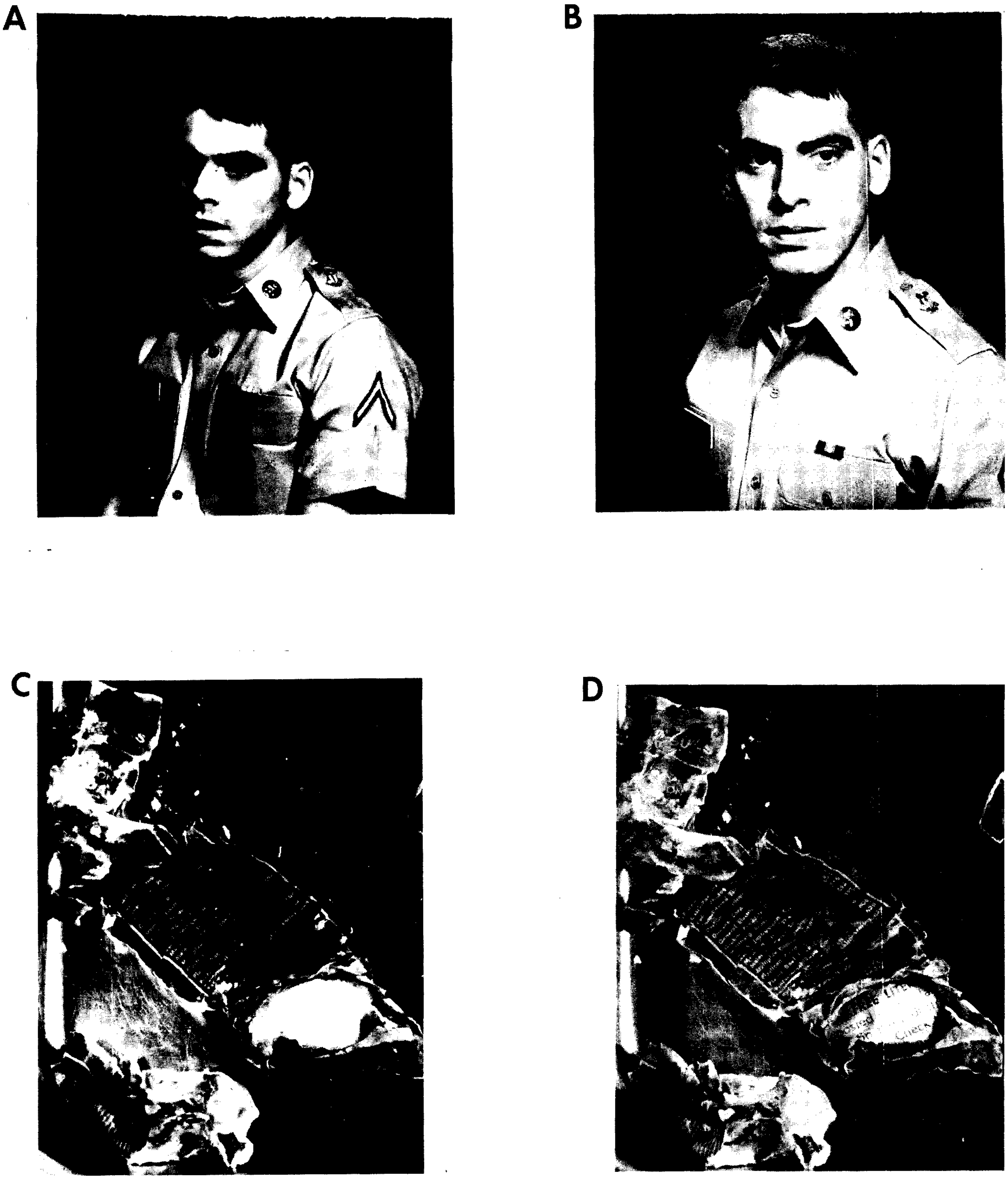

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Figure 7–2. Effects of infrared.

but remember, infrared light is invisible and can penetrate many materials that visible light will not.

b. As a general rule, use new models and metal-body cameras with infrared film. When in doubt about whether or not a particular camera is suit-

INFRARED

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Figure 7-3. Infrared role in the aerial mission.

able for infrared, ask someone who has used one, or better yet, try out the camera before going on an assignment. Two cameras that military still photographers commonly use with infrared film are Still Picture Camera KE-4(1) and Still Picture Camera KE-12(2). Actually, the camera you select for an assignment will depend more on the nature of the assignment than on the film.

c. The film size you choose depends on the camera.

7-11. Hypersensitizing Increases Film Speed

a. You can increase the speed of infrared film by hypersensitizing; however, it is not a necessity. When time and facilities permit, the increase in film speed is worth the effort.

b. Hypersensitizing film is performed equally to all parts of the film in total darkness. To hypersensitize film you immerse it for about 3 minutes in either a weak solution of either ammonia or triethanalamine. If you use ammonia, use one part of 28-percent ammonia to 25 parts of water. If you use triethanalamine, use a 1-percent solution. Both solutions should be 50 degrees Fahrenheit or less. Dry the film rapidly in dust free air.

c. The requirement to hypersensitize in total darkness is difficult to fulfill because infrared film is sensitive to light we cannot see. Because almost every light source radiates some infrared that will fog the film, you must attempt to achieve as total a darkness as possible. The hypersensitizing must be even so that all parts of the film have the same speed, otherwise your negative will be streaked with light and dark areas. Any dust and dirt on the film will cause a spot and may get caught on rollers and scratch other parts of the film.

d. When the film is dry you're ready to load it into the camera.

7-12. Load Film in Darkness

a. Load infrared film into film holders in total darkness. Again we refer to total darkness because infrared film is sensitive to light we cannot see.

b. Wooden film holders are a poor choice because they may not protect the film from being fogged. Metal holders in good condition are the best.

c. Use dark slides that have *five dots* embossed on the top. The dots indicate the silver side of the slide, and the number of dots indicates that the slide will protect the film from infrared radiation.

7-13. Use Reddish Filters

a. In addition to being sensitive to infrared radiation, infrared film is also sensitive to ultraviolet and to some blue light. Thus, under normal lighting conditions, objects reflecting these wavelengths will record on infrared film. Ultraviolet and blue light make the pictures look more natural, but because infrared film is usually used to take advantage of the special characteristics of infrared radiation you will probably want to filter out any ultraviolet or blue light.

b. You can use almost any reddish (A or F) filter because it transmits infrared and absorbs ultraviolet and blue. Wratten filters #87 and #89A are infrared filters. They look black because they do not transmit any visible light, but they do pass infrared.

c. You do not need a filter at night or under blackout conditions when the only source of light is strictly infrared.

7-14. Type of Light Source is not Critical

a. Infrared film requires that the subject be just as brilliantly illuminated with infrared as other films require illumination by visible light. Fortunately, most sources of visible light (the sun, regular flashbulbs, floodlamps, and others) radiate enough infrared for photography, but we find that the amount of infrared in sunlight is extremely variable and unpredictable. Using an exposure meter to measure the infrared is unreliable because an exposure meter mainly measures visible light, not infrared light. The following statement about infrared radiation is not true absolutely, but you may use it as a *guide* in evaluating the infrared brightness of a scene: a scene is just as bright in infrared as it is in visible light.

b. Instead of visible light you can use infrared or blackout flashbulbs 5R or 22R to provide the required illumination. Blackout flashbulbs usually produce no visible light—you might see a very faint, dull red, but that's all.

c. Once you have illuminated the scene, the next step is to get a sharply focused image.

7-15. More Lens-to-Film Distance Required

a. The longer wavelength of infrared results in a longer focal length for a given lens. This means that the lens must sit farther from the film for a sharp focus. Because infrared is invisible, direct focusing by sight is not possible, so you need to use other means of focusing.

b. Some cameras have built-in indicators. Still Picture Camera KE-4(1) has a white dot and a red dot on the depth-of-field scale. For regular film you would use the white dot, but for infrared film you rotate the focusing ring until the footage indicator is opposite the red dot.

c. Luckily, the amount you must extend the lens or bellows for a sharp focus is small, and you need only a slight increase after you have focused the scene visually. *For example,* you need to extend the lens of Still Picture Camera KE-

12(2) only about one-quarter of 1 percent of the focal length or about 1/100 of an inch. Focusing is most critical for very close subjects and less critical for far away subjects, because as the distance to the subject increases the depth of focus also increases. Thus, for distant scenes you may use the hyperfocal distance.

d. Two other methods of improving image sharpness are to focus on ground glass with a Wratten #25 (red) filter over the lens, and to stop down the aperture. By using the red filter you are focusing the red light; its wavelength is closest of all visible light to that of infrared light. Stopping down the aperture increases the depth of focus, but it also reduces the amount of exposure.

e. After you have focused the image, determine the exposure.

7–16. How to Calculate Exposure

a. In daylight use the same exposure for infrared film that you would use for a panchromatic film of the same speed. Add a little extra exposure on dull days.

b. For photoflood lamp or regular flash determine the f-number by the following formula:

$$\text{f-number} = \frac{\text{lamp guide number}}{\text{lamp-to-subject distance}}$$

Then open an extra half stop for a Wratten #89B filter, and open an extra full stop for Wratten filters #87 or #88A.

c. For blackout flashlamps you don't need any filters. Use the following approximate guide numbers to determine the f-number with the above formula.

Lamp	*Guide number*
#22R	70
#5R	50

d. When you rely on estimated exposures, it's best to make three exposures whenever possible. Make one exposure two stops over the estimate, one at the estimate, and one two stops under. This will assure that you have one good negative after processing.

7–17. Process Film in Total Darkness

a. The invisible radiation of infrared can fog infrared film any time until the film is fixed. Since most lights including safelights emit infrared, it's best to process the film in total darkness. You can use a Wratten series 7 safelight if placed more than 3 feet from the film. This safelight is NOT safe for panchromatic or orthochromatic films.

b. Other than lighting, there is no difference between processing infrared film and other film. The steps (develop, stop, fix, wash, and dry), the solutions, and the temperatures are the same. The final product of the process, a negative, is just like any other black and white negative.

7–18. Printing is the Same as for Other Films

An infrared negative is just like any other negative, and there are no special techniques in making prints. Use regular print paper and standard printing procedures.

7–19. Summary of Infrared Techniques

a. When in doubt about whether a camera is light tight, try it out before going on an assignment.

b. To increase the film speed, hypersensitize it by holding the film in a weak solution of ammonia or triethanalamine for 3 minutes.

c. Load the film in total darkness, not subdued light.

d. Use metal film holders and dark slides with five embossed dots.

e. Use red or infrared filters when the scene is visibly illuminated.

f. Most light sources are suitable for infrared photography, but blackout flashbulbs provide safety in combat and eliminate the need for filters when you photograph in the dark.

g. Increase the lens-to-film distance for a sharp focus by using mechanical indicators on the camera, extending the lens a stated amount, using the hyperfocal distance for distant scenes, or focusing through a red filter.

h. Stopping down increases the depth of focus.

i. Use visible light to estimate daylight exposures, and use lamp guide numbers for artificial light exposures.

j. When possible make three exposures, one two stops over, one at, and one two stops under the estimate.

k. Process the film in total darkness or 3 feet from a Wratten series 7 safelight.

7–20. Final Summary

a. Infrared radiation is invisible. Thus, film sensitive to infrared can record images in apparent darkness.

b. The long wavelength of infrared allows the radiation to pass through some objects that are opaque to visible light.

c. Pictures made by infrared film do not look natural because objects do not reflect the same amount of infrared as they do visible light. Some objects are invisible, some show more clearly, and others just vary in degree of brightness.

d. Infrared film speed is increased by hypersensitizing.

e. Some cameras are not light tight to infrared. Make sure yours is.

f. Infrared film is sensitive to ultraviolet light, so you need filters in normal light to eliminate the ultraviolet.

g. You need a definite amount of illumination for an infrared photograph, but you may use most types of light sources.

h. The focal length of a lens is increased with infrared.

i. Infrared film must be processed in the dark, but the other procedures for processing and printing remain the same as for other film.

7-21. Review Questions

a. State a reason for using infrared film in each of the following fields.

Field	*Reason*
(1) Combat	....
(2) Investigation	....
(3) Medical	....
(4) Reconnaissance	....

b. Describe the solutions used for hypersensitizing.

c. How can you identify infrared dark slides?

d. What color is an infrared filter?

e. When and why are infrared filters necessary?

f. Some cameras have mechanical indicators for focusing with infrared film, and other cameras require that the lens be extended a specific amount. State another method of getting a sharp infrared image.

g. What f/stop would you use to photograph a subject that is 9 feet from a #22R blackout flashbulb (guide number 70)?

h. What safelight can you use when processing infrared film?

7-22. Answers to Review Questions

a.

Field	*Reason*
(1) Combat	For safety.
(2) Investigation	To detect forgeries.
(3) Medical	To diagnose skin conditions.
(4) Reconnaissance ...	To get clear distant details.

b. One part 28-percent ammonia to 25 parts water or a 1-percent solution of triethanalamine.

c. Five dots are embossed on the top of the silver side.

d. It looks black.

e. When the scene is illuminated with visible light, because infrared film is also sensitive to ultraviolet and blue.

f. Focus on ground glass with a Wratten #25 filter over the lens, or stop down the aperture.

g. F/8.

h. Wratten series 7.

CHAPTER 8

FLASH PHOTOGRAPHY

Section I. GENERAL

8-1. Introductory Information

a. You, the photographer, will often have to provide all or part of the light required to produce good pictures. Films record images by the amount of reflected light; thus, the darkness must be illuminated to get a photograph. Even normal indoor lights are usually not bright enough for photography, so you will have to use more intense lights. And, strangely, additional light may even be required in bright sunlight to bring out the details of shadow areas. Artificial light is used to provide all the light, key light, fill-in light, separation light, texture, contrast, or any combination of these.

b. There are two general types of artificial light used in photography—flood and flash. Although the following text is a discussion of flash photography, keep in mind that floodlamps can be used in place of flashbulbs. The principal differences between flood and flash, and thus the advantages or disadvantages of one over the other, are—

(1) The light from a flashbulb shines for but a brief moment.

(2) A new flashbulb must be used for each exposure. The one true exception to this fact, the electronic flash, will be discussed later in this chapter. The new four-in-one flash cubes are not an exception to this fact because they are really four separate flashbulbs built as one unit.

(3) Flashbulbs are more portable than floodlamps. Even though using flashbulbs requires a larger number of bulbs, the small size and weight of the bulbs and auxiliary equipment make flash equipment easier to carry. Also floodlamps usually need to get power from commercial powerlines, whereas flashbulbs operate on batteries.

8-2. Batteries Supply Power for Flashbulbs

a. Power supplies for flashbulbs come in many varieties and forms. Small lamps are usually operated from power supplies that are built into and part of the camera. For medium size lamps the power supply is usually part of the flash holder, which may be attached to the camera or held away from the camera (fig. 8-1). To operate large lamps or many lamps at the same time may require power separated from both the camera and the flash holder(s).

b. The power may come from 100-volt ac or dc lines, but most commonly the power source is a battery. The dry cells used to fire flashbulbs look exactly like flashlight batteries. Even though an ordinary flashlight battery is able to fire a flashbulb, dry cells designed for photography are more dependable and will last longer as power sources for flashbulbs. Since there is an internal difference between the look-alike batteries used for flashbulbs, flashlights, and transistor radios, get in the habit of reading what is printed on the battery and using direct replacement types.

c. Many flashguns (power supplies) use a combination of battery and capacitor. A capacitor is a device that can store a large amount of electricity and with the flick of a switch release that electricity very quickly. The battery slowly charges the capacitor between flashes, and then the capacitor discharges sending a large current through the flashbulb. The battery-capacitor combination reduces strain on the battery, is used to operate many lamps in unison, and is used to fire large flashbulbs.

8-3. Replace Old, Worn, or Damaged Batteries

a. Some dry cells are rechargeable and should be recharged at regular intervals. However, it is better to replace most worn out dry cells with new ones.

b. The life of a battery depends on the size of the battery and the size of the flashbulbs. The large number of sizes makes it impossible for us to be specific about how long a battery will last. In very round figures, when size D (flashlight size) batteries are used to fire average lamps (#5), then the battery is good for about 100 flashes. Also, a battery just sitting on a shelf doing nothing will become old and useless. The length of time that a battery will last without use is called shelf life. Military batteries and many commercial types have an expiration date stamped on the battery.

c. Batteries lose efficiency as the temperature

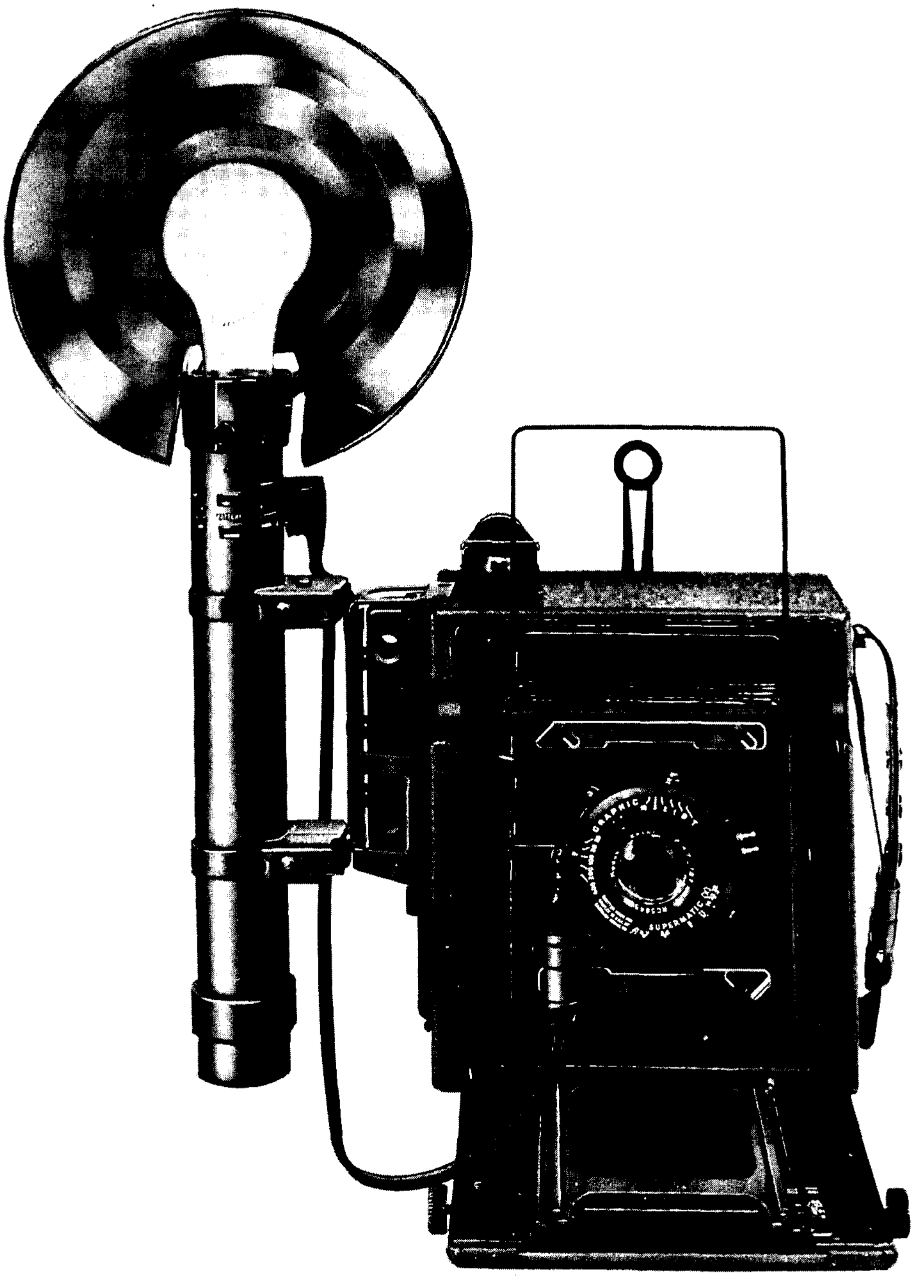

Figure 8-1. Flash and camera.

decreases. That is, they become less capable of supplying current as the temperature gets colder. The efficiency of a battery is 100 percent at 70 degrees Fahrenheit, 70 percent at 40 degrees Fahrenheit, and 35 percent at 0 degrees Fahrenheit. Thus, the power is reduced to about ½ as the temperature drops to freezing. In cold weather and whenever possible, keep the batteries warm by leaving them indoors, inside your coat, or some other warm (not hot) place until they are needed. Another aid to assure operation in cold weather is to use fresh batteries.

d. Regularly check batteries for their physical condition. Replace any battery that has a physical defect such as a dent, crack, or bulge. Discard batteries that have stuff oozing out, as this stuff is either acid or alkaline and will damage the battery holder and corrode contacts.

8-4. Check Leads and Contacts

a. Corrosion and dirt are the principal causes of flash failure. The wires that carry the electricity from the battery to the flashbulb are connected to metal pieces called contacts. They make contact to the battery terminals and to the flashbulb. These contacts have to be clean bare metal because corrosion, dirt, or oil film will prevent contact and result in an open or break in the current path.

b. Contacts are easily kept clean with just a clean dry cloth. Once corrosion gets a good hold a more extensive repair job may be necessary.

c. Check connecting leads and cables before going out on an assignment. As with any piece of equipment, if you see *any* damage have the item repaired or replaced.

8-5. Electricity is Applied to the Lamp Base

a. Electricity is connected to the flashbulb through two metal contacts on the base of the lamp. As with other contacts, corrosion and dirt will interfere with making a good contact and prevent flashing. It's a good practice to wipe the base of the flashbulb with a clean cloth before placing the bulb in the flash holder.

b. There are four common styles of flashbulb bases—screw, bayonet, pinless, and glass (fig. 8-2).

(1) The screw base looks the same as an ordinary household lamp. The screw part is one contact, and a spot of metal in the center of the bottom of the base is the other contact.

(2) The bayonet base has two pins on the sides of the base that hold the lamp securely in the lamp socket and form one of the contacts with the sides of the base. The other contact is a spot of metal in the center of the bottom of the base.

(3) The pinless base is like a small bayonet base but without the pins and with an indented rim around it. The flashbulb is held in the lamp socket by spring pressure and may be mechanically ejected. There is an adapter that permits you to use the pinless base flashbulbs in bayonet sockets.

(4) Glass base flashbulbs have two loops of wire coming out of the bottom of the base that are used as contacts. One loop is bent to one side of the base, and the other loop is bent to the other side. The lamp is held in the socket by spring pressure.

c. The type of lamp base you use depends on the type of socket you have on your lampholder. The size of the bulb part of the flashbulb, which can be as small as a fingernail or as large as a large household lamp, depends on the size of your reflector.

8-6. Center the Bulb in Reflector

The center of the bulb part of the flashbulb should be at the focal point of the reflector when the bulb is in the flash holder. If the bulb is not centered correctly, the effectiveness and efficiency of the light from the flashbulb will be reduced. This means you should use only those lamps recommended for a combination of holder and reflector to get the best light output from the flashgun.

8-7. Burning Metal Produces the Light

a. Wires connect the contacts on the flashbulb base to a primer (fig. 8-3). Electric current passing through the primer causes the primer to explode and ignite the wire filling.

b. Burning wire filling produces the light. The filling is a metal such as magnesium that will burn with a brilliant white light. Actually the color is reddish, but this is not visibly noticeable. The filling may be fine, loosely packed wire or a crumpled foil.

c. Burning the wire filling requires oxygen, so the flashbulb is not evacuated as a household

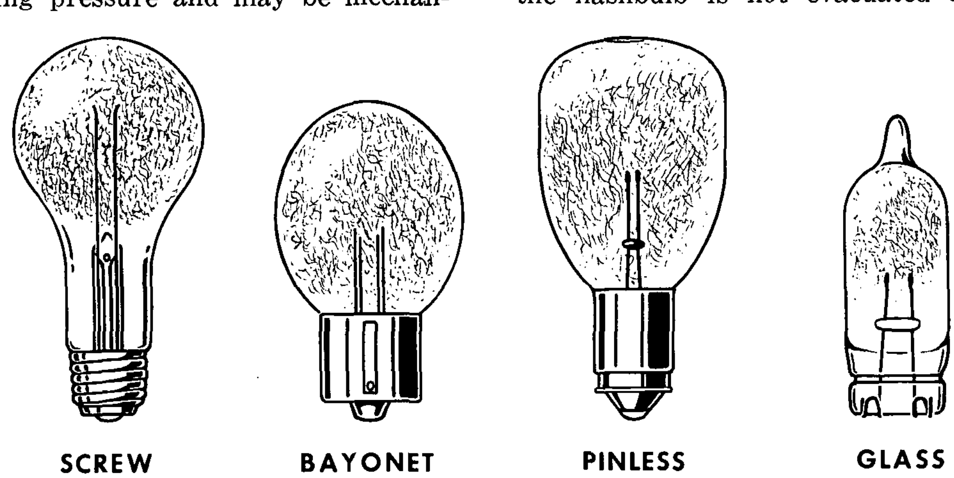

Figure 8-2. Flashbulb bases.

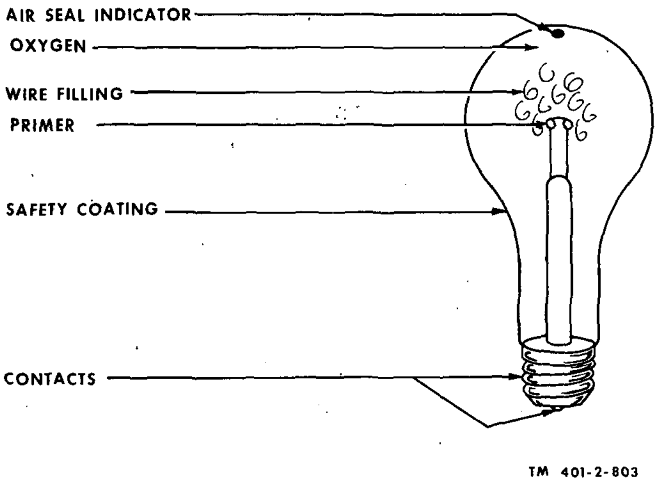

Figure 8-3. Flashbulb construction.

lamp is; the flashbulb contains oxygen. If, due to some fault in the lamp, there is not enough oxygen, there will be no flash. Many flashbulbs have a blue spot (actually a cobalt salt) on the glass that turns pink when there is not enough oxygen. DO NOT USE THE BLUB when the blue spot has turned pink.

d. The burning metal produces heat and explosive force as well as light. For safety, the glass is heat resistant and coated with a plastic to prevent the glass from breaking and scattering pieces. Even though modern flashbulbs have this safety feature, DO NOT FIRE BARE BULBS near other people. The lamp that you are using might be defective. It's not likely, but why take any chance when there are clear plastic covers for all types of reflectors that give added safety protection. Also, a handkerchief or other diffusing cover will provide protection and reduce the harshness of the light when you are photographing up close.

Section II. FLASHBULB CHARACTERISTICS AND SYNCHRONIZATION

8-8. Brilliance and Time Vary From Bulb to Bulb

a. To you the flash of a flashbulb may last just a moment, but when compared to the speed of your shutter the duration of the flash may be a very short or a very long time. Since the shutter must be open during the flash, you must consider the shutter action with the timing of the flash when selecting a flashbulb.

b. Each flashbulb manufacturer prints data concerning brilliance and time about its own flashbulbs. The data may be printed in words, charts, or graphs and is usually packaged with the bulbs. Figure 8-4 is a typical graph of the flash of a flashbulb.

c. Let's look at the operation of the flash shown by the time-intensity curve in figure 8-4. The vertical height shows the brightness in lumens. The horizontal scale shows the number of milliseconds (thousandths of a second) after the flash is triggered. For the first few milliseconds no light is emitted because it takes this long to fire the primer and ignite the filler. From 3 to 7 milliseconds the flash gets brighter because the burning is spreading through the filler. After a peak brightness at 7 milliseconds the brightness decreases as the filler is burned up. Different types of lamps have different time-intensity curves.

d. The area under the curve indicates the amount of light available for exposure of the film; however, if the shutter opens too late or closes too soon some of the light will not be used. Look at the curve in figure 8-5. A shutter speed of 1/200 second is 5 milliseconds, and if this shutter opens when the flash is triggered, the shutter will close before any light is available. At a shutter speed of 1/50 second (20 milliseconds) this same shutter closes before the peak of the flash, and less than half the light is used. Thus, the shutter must open and close at the proper time to get the most effective use of the flash.

e. Timing is not the only difference between bulbs. Peak brightness, total light, and the shape of the time-intensity curve also vary with type of flashbulb.

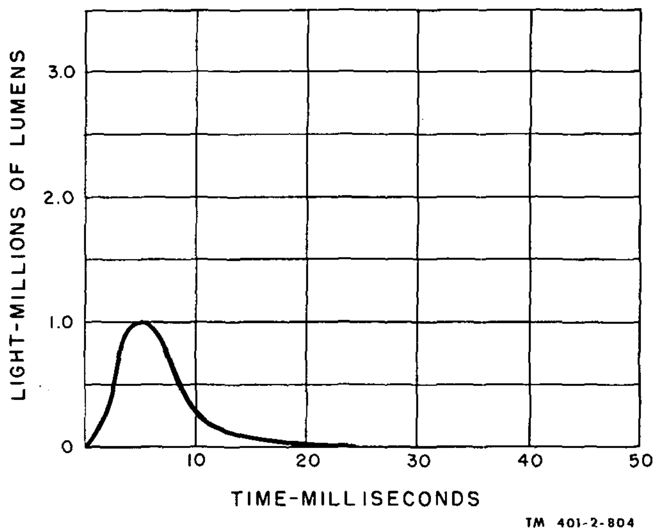

Figure 8-4. Typical time-intensity curve.

8-9. Class S Bulbs are Slow Firing

a. Class S lamps take a long time to fire and reach their peak brightness, and they produce a very brilliant light. An example of a class S lamp is a Photoflash No. 50, which reaches a peak of 6 million lumens 30 milliseconds after it is triggered. The time-intensity curve is shown in figure 8-5.

b. Use class S flashbulbs to illuminate large, open areas, or use them with a small lens opening because of their high light output.

c. Because class S flashbulbs take a long time to fire and reach their peak, you must use a slow shutter speed (1/25 second or less) and delay the opening of the shutter for 20 milliseconds. Another method of obtaining full class S lamp flash is the open flash technique.

8-10. Open Flash Uses the Full Flash

a. The open flash technique is performed in the following sequence. When you are all set up and ready to make an exposure—

(1) Cover the lens.
(2) Open the shutter.
(3) Uncover the lens.
(4) Fire the flash.
(5) Cover the lens.
(6) Close the shutter, and you have completed the exposure.

b. There are several advantages of the open flash. For one thing there is *no* critical timing of flash and shutter. The full flash is used, and many flashbulbs can be fired one at a time for special effects. When you use more than one lamp, fire them all in the same step of the procedure. There is no need to cover and uncover the lens for each flash unless the natural light of the scene is bright enough to cause undesirable exposure.

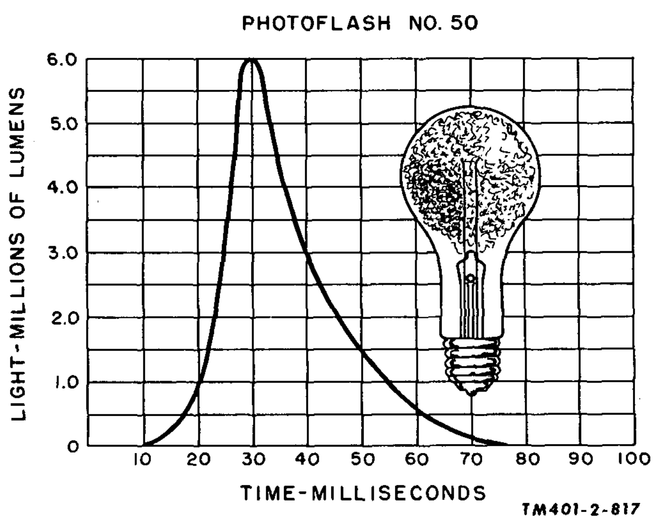

Figure 8-5. Class S flashbulb curve.

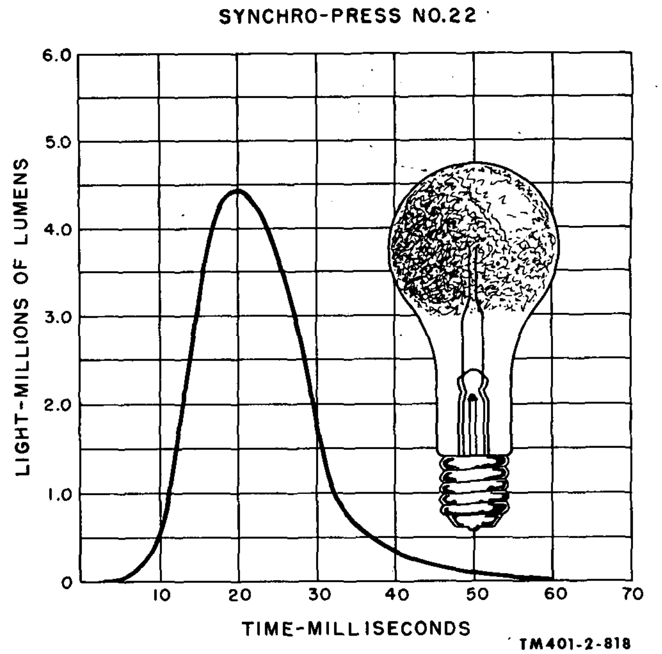

Figure 8-6. Class M flashbulb curve.

c. One disadvantage of open flash is that the camera must be rigidly mounted during the exposure. Also there is the possibility of the subject moving during the long exposure and the possibility of undesirable exposure by other lights.

8-11. Class M Bulbs are Medium Firing

a. Class M flashbulbs reach their peak output faster than class S lamps but generally have a lower light output. The Synchro Press No. 22 flashbulb is an example of a class M lamp. It reaches a peak of 4.5 million lumens in 20 milliseconds. The time-intensity curve of the Synchro Press No. 22 is shown in figure 8-6.

b. The class M flashbulb is the most common class of lamp used with synchronized between-the-lens shutters.

8-12. Synchronized Flash Uses Delayed Shutter

a. The common method of synchronizing the shutter with the flash is to use a device that delays the opening of the shutter. As an example, let's use a shutter speed of 1/100 second with a Synchro Press No. 22 lamp (fig. 8-6).

b. If the shutter and the lamp are triggered at the same time, the shutter will close in 10 milliseconds (1/100 second) or before the flash has had time to fire. The result is no exposure.

c. By delaying the opening of the shutter for

15 milliseconds, the shutter does not open until the scene is lit; 1/100 second later or 25 milliseconds after the flash is triggered, the shutter closes. The result is that the shutter was open while the flash was at its brightest, and an exposure was made.

d. The delay of the shutter is performed by either a mechanical device controlled by a clock-type escapement movement or an electrical device called a solenoid. All commercially available solenoids and many mechanical delay mechanisms are adjustable.

e. Photo cells, which convert light to electricity, are also used to control the shutter. Using a photo cell for synchronization is a modification of the open flash technique. The shutter is opened when the flash is triggered. The light of the flash exposes the film and strikes the photo cell, and the electricity produced by the photo cell is used to close the shutter. This method is principally used in aerial systems, but there are hand-held ground cameras that use photo cells to control the exposure.

8–13. Class FP Bulbs Have Long, Flat Peak

a. Class FP flashbulbs are about as fast as class M lamps in reaching their peak, but class FP bulbs remain at their peak for a long time. *For example,* the No. 6 flashbulb reaches 3/5 of a million lumens in 20 milliseconds and stays above half a million lumens for 20 milliseconds (fig. 8–7).

b. The fairly flat, long peak of a class FP flashbulb assures even exposure with focal plane shutters. A focal plane shutter does not expose all of the film format at the same time, so the light intensity must remain constant as the shutter moves across the film plane to give the same exposure to all parts of the film.

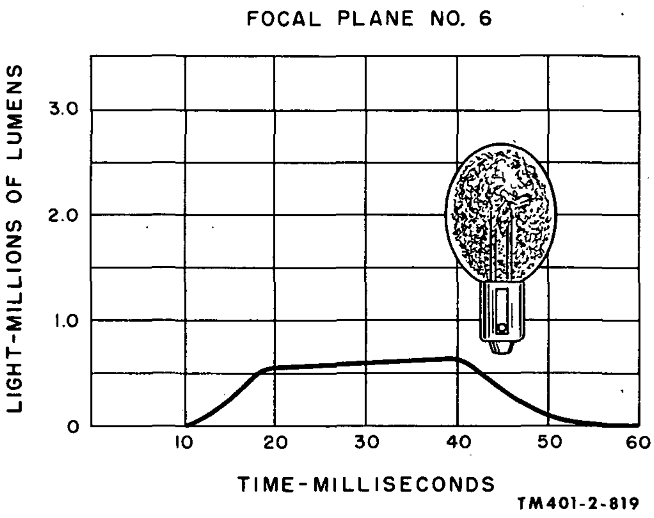

Figure 8–7. Class FP flashbulb curve.

8–14. Newest Varieties of Flashbulbs

a. Photographic equipment has been improved rapidly, and as a photographer you must keep up with the new developments even though in much of your military photographing you will continue to use established equipment and material. The newest change in flashbulbs is a drastic reduction in size. The three new lamps we'll discuss are the M series, AG (all glass) lamps, and the flashcube.

b. The M-series lamps are numbered M–2 and M–3. These bulbs are one-fourth the size of the No. 5 and have a pinless base. The M–2 (fig. 8–8) peaks at 14 milliseconds, thus giving precise synchronization with any type of camera. The M–3 (fig. 8–9) peaks at 17.5 milliseconds providing acceptable synchronization with any type of camera.

c. The world's smallest flashbulb, about the size of a jelly bean, is the AG–1. This bulb has an all glass base and about the same light output as the M–2. It peaks at 12 milliseconds so it must be used with X (para. 8–15*b*) or F synchronization at shutter speeds up to 1/60 second (fig. 8–10).

d. The newest development in flash photography is the flashcube. This is a cube containing four miniature flashlamps, each with its own reflector. The cube rotates after each exposure, permitting you to take a series of four exposures without changing lamps. The lamps have lower total output than the AG–1 and can be used only with cameras designed for them or in special adapters for other cameras (fig. 8–11).

8–15. A Speedlamp has no Delay

a. An electronic flashlamp, also called a speedlamp or repeating flash unit, produces light in the same manner as a fluorescent lamp. An electric arc passes through a gas, Xenon. With this process, the Photographic Repeating Flash Unit LM–33(1) (fig. 8–12), can average over 50 million lumens during the flash. Although the light is extremely bright, the duration of the flash is extremely short.

b. The reaction of an electronic flash unit is so quick that the flash is over in less time than it takes to open most shutters. Thus, X synchronization is often required. In X synchronization you delay the flash until the shutter is fully open, whereas in other types of synchronization you delay the shutter.

c. Because electronic flash units are fast oper-

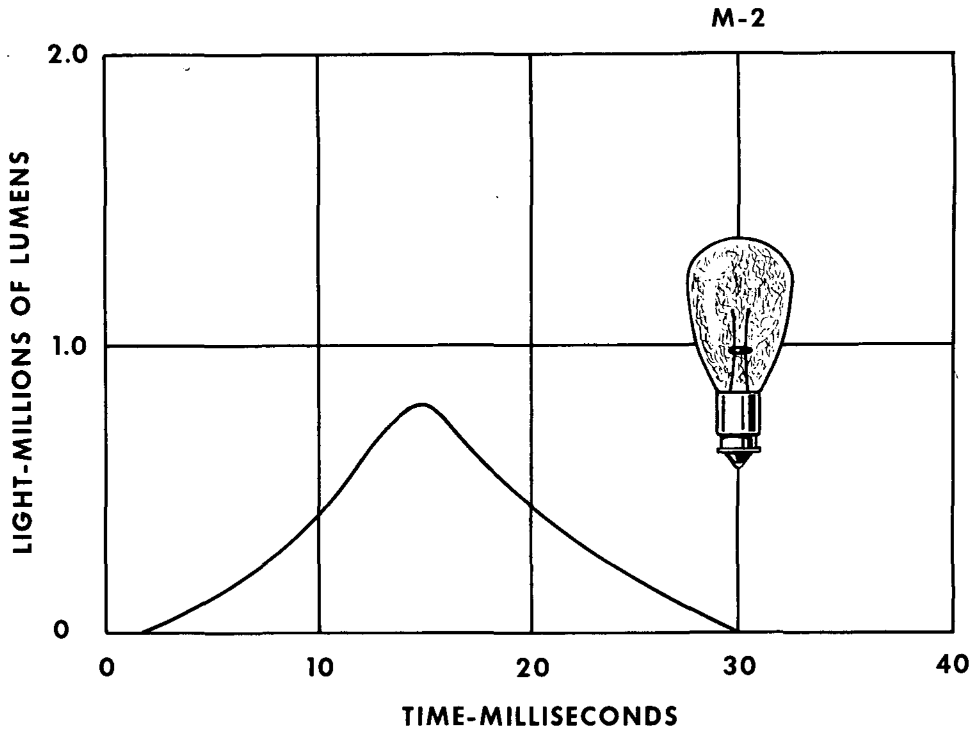

Figure 8-8. M-2 flashbulb curve.

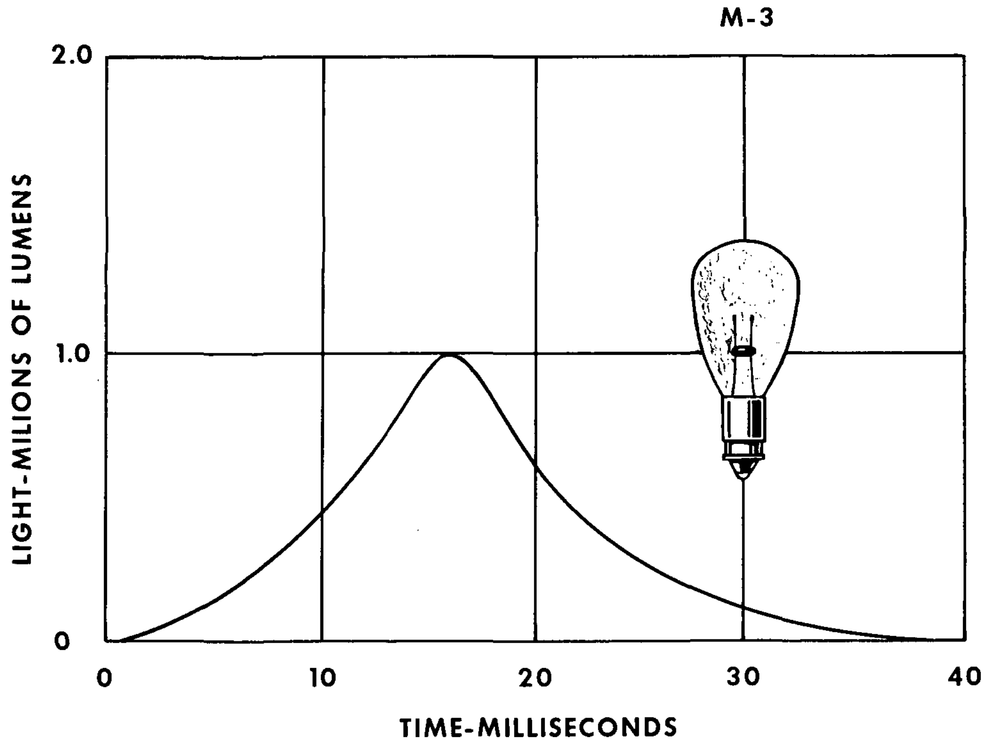

Figure 8-9. M-3 flashbulb curve.

ating, shutter speed has almost no effect, and rapid photographs are possible. At very slow shutter speeds the shutter may not open fast enough, but this presents no problem with X synchronization. And for the shutter to cut off any of the flash its speed has to be 1/1,000 second or faster.

8-16. B is Blue for Daylight

a. Another advantage of speedlamps is the blue tint to the color of the light. Regular flashbulbs have a yellow or reddish tint like regular household lamps. Electronic flash units have the color of daylight, which is soft and cool.

b. Some flashbulbs have a blue plastic coating

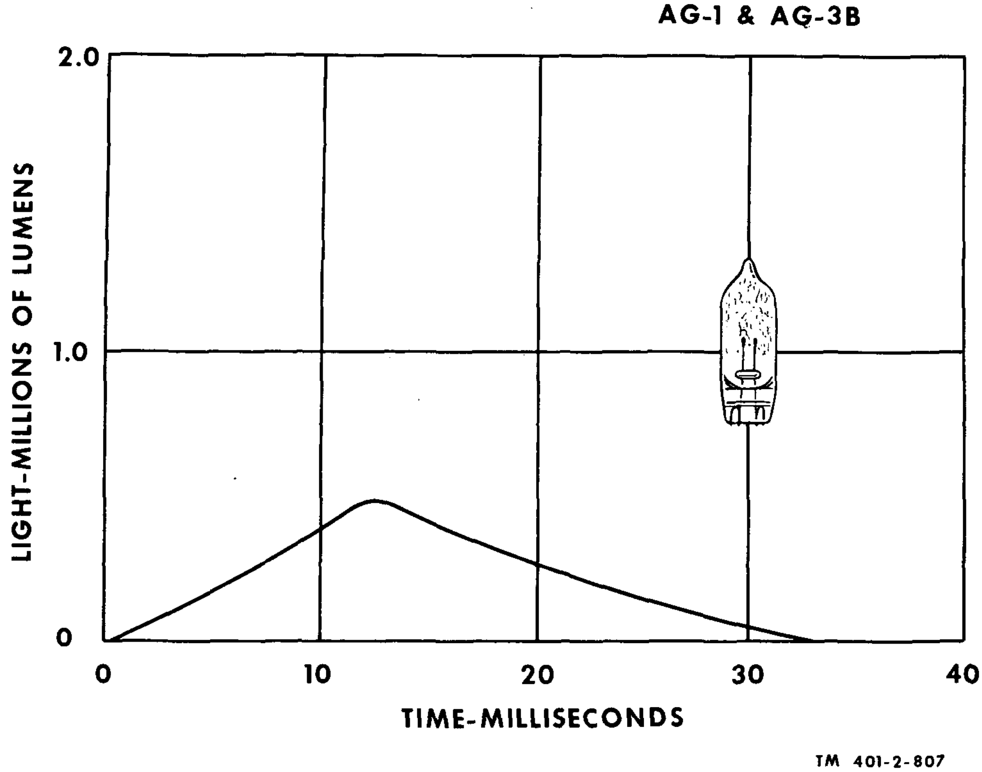

Figure 8-10. AG-1 flashbulb curve.

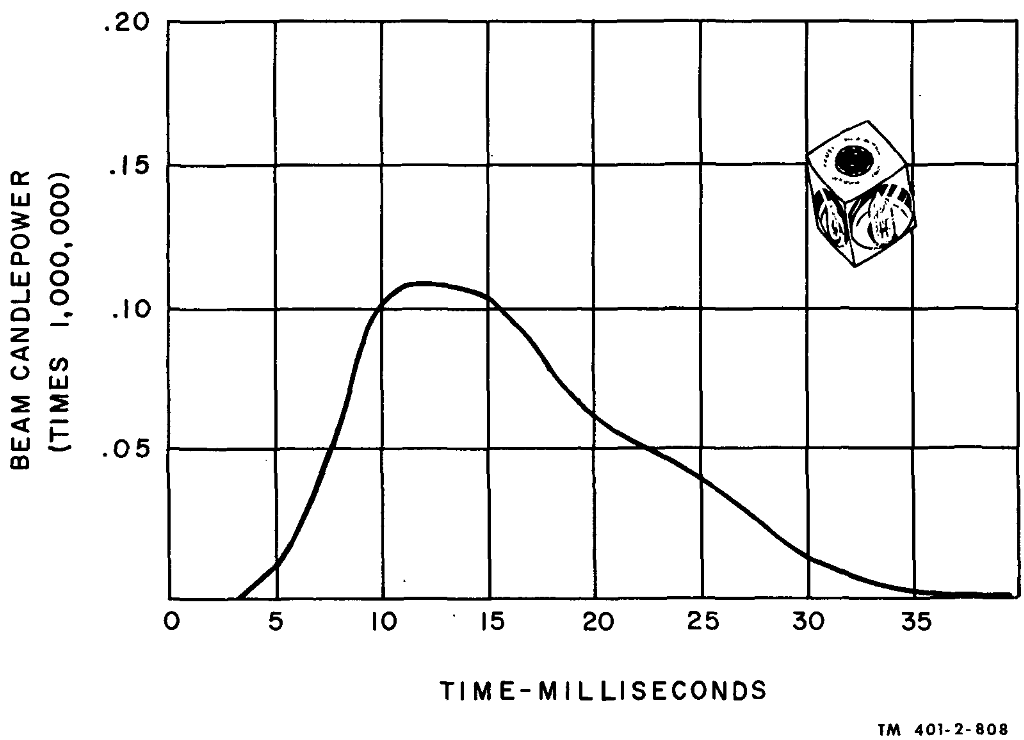

Figure 8-11. Flashcube curve.

so that they give off a light similar to daylight. Daylight flashbulbs have the letter B at the end of their names such as lamp number 22B or AG-1B. You should use speedlamps or blue bulbs

Figure 8-12. The LM-33(1).

with black and white film or daylight color film. And, you can use clear flashbulbs with black and white film or daylight or type A color film if a conversion filter is placed over the lens.

8-17. Lamp Speed vs Shutter Speed

a. Up to now we've discussed flashbulbs as if you were going to use every bit of the light output of each lamp. You will not always use all the light because a good exposure requires a specific amount, and the flash should give more light than you need. The amount of light that the film receives is determined by the brightness of the scene (intensity of flashbulb), light-gathering ability of the lens (f/stop), and how long the film is exposed (shutter speed).

b. Exposure equals time multiplied by intensity (E=t x I). We'll look at the time part of the formula first. You've selected a flashbulb, one that will be bright enough to light the scene and fit your flashgun. Now we'll set the shutter speed.

c. You cannot cut the exposure time in half simply by dividing the shutter speed in half as you can when using daylight or photofloods, because the flash output is not constant. However, as the area under the flashbulb's time-intensity curve represents the total light output, a time that divides this area in two will reduce the exposure by one half. *For example,* if we used the flashbulb whose time-intensity curve is shown in figure 8-13 and delayed the shutter 10 milliseconds, then a shutter speed of 40 milliseconds (1/25 second) would leave the shutter open during 96 percent of the flash. Half the light would occur during the first one-third or 13 milliseconds. Thus, the shutter would have to be three times faster to reduce the exposure by one-half.

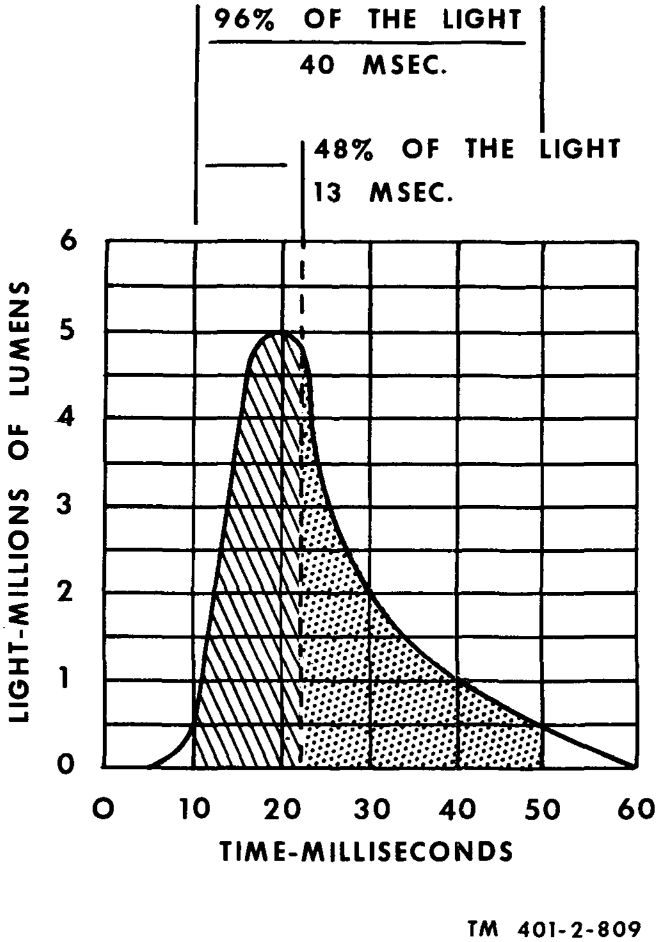

Figure 8-13. Reducing exposure time.

8-18. Guide Number Determines F/Stop

a. Exposure time is normally the duration of the flash and you control the amount of exposure by adjusting the lens opening. To make your calculation of the required f/stop easy, manufacturers of lamps print guide numbers for their lamps. Specific guide number data is packaged with the flashbulbs, and an example of the type of data is shown in the chart below. Table 8-I also lists some common flashbulb guide numbers.

Film	Guide numbers in 2" to 3" polished reflector				
	F, X or M 1/30th or slower	M Sync only			
		1/60	1/125	1/250	1/500
All Weather Pan	160	130	110	80	65
Kodacolor	70	55	48	34	28
Kodacolor-X	110	90	80	55	45
Panatomic-X	90	70	60	44	36
Plus-X	180	140	120	90	70
Verichrome Pan	160	130	110	80	65
Versapan	160	130	110	80	65

b. The required f/stop is determined by dividing the guide number by the lamp-to-subject distance. For instance, if the subject is 5 feet from the lamp and the guide number is 40, the f/stop is 40/5 or 8 (actually f/8). Work the problem in figure 8-14 using the chart.

c. The answer to the problem in figure 8-14 is f/11 (90/8=11.25).

d. The guide numbers stated by a manufacturer for a given lamp are based on subjects of average brightness, a particular reflector, and a given film speed. For dark subjects (people with dark colored clothing, brown or black objects), and for open areas, open an additional ½ or 1 f/stop. For light subjects (white clothing or light colored objects) and a closed in area (near walls or low ceilings) close down ½ to 1 f/stop. A diffuse type of reflector requires one additional stop more than a polished reflector.

e. Manufacturers' data generally state the guide number for many film speeds, and it is not difficult to determine the guide number for any

Table 8-1. Flashbulb Guide Numbers

Lamp number	Reflector (The value stated is the diameter in inches of a polished reflector, unless otherwise stated.)	Shutter speed (The guide number of the slowest speed given may be used for slower speeds.)	ASA speed rating (The guide number is for tungsten film unless otherwise stated. Numbers for other ASA ratings can be determined by multiplying the guide number for ASA 100 by 1/10 the square root of the other ASA rating.)			
			25	50	100	200
			Guide numbers (for average scenes)			
AG-1	2	1/30	67	95	134	188
		1/100	47	66	94	132
		1/200	36	50	72	100
		1/400	29	41	58	82
FP-26	4 to 5	1/50	100	141	200	282
		1/100	70	100	140	200
		1/200-1/250	48	67	96	134
		1/400-1/500	34	48	68	96
		1/1000	22	31	44	62
M-2	3 to 6	1/30	90	126	180	252
M-5	3 to 6	1/30	134	190	268	380
		1/100	100	141	200	282
		1/200	90	126	180	252
		1/400	67	95	134	190
M-25	3 to 6	1/30	134	190	268	380
No. 0	6 to 7	1/50	125	175	250	350
		1/100	95	134	190	268
		1/200-1/250	75	106	150	212
		1/400-1/500	55	77	110	154
No. 2	7	1/50	180	255	360	510
		1/100	140	198	280	396
		1/200-1/250	105	148	210	296
		1/400-1/500	75	105	150	210
No. 2A	7	1/50	100	141	200	282
		1/100	70	100	141	200
		1/200-1/250	50	70	100	141
		1/400-1/500	36	51	72	102
		1/1000	26	37	52	74
No. 3	7	1/25	240	340	480	680
		1/50	175	245	350	490
		1/100	120	170	240	340
No. 5	4 to 6	1/25	123	174	246	348
		1/50	112	158	224	316
		1/100	100	141	200	282
		1/200	78	110	156	220
		1/400	63	87	126	164
No. 5	4 to 6 (satin finish).	1/25	100	141	200	282
		1/50	90	126	180	252
		1/100	78	110	156	220
		1/200	63	84	126	168
		1/400	49	70	98	140

Table 8-I. Flashbulb Guide Numbers—Continued

Lamp number	Reflector (The value stated is the diameter in inches of a polished reflector, unless otherwise stated.)	Shutter speed (The guide number of the slowest speed given may be used for slower speeds.)	ASA speed rating (The guide number is for tungsten film unless otherwise stated. Numbers for other ASA ratings can be determined by multiplying the guide number for ASA 100 by 1/10 the square root of the other ASA rating.)			
			25	50	100	200
			Guide numbers (for average scenes)			
			daylight film	daylight film		
No. 5B	4 to 6 (satin finish).	1/25	75	105	150	210
		1/50	70	100	141	200
		1/100	60	84	120	168
		1/200	48	67	96	134
		1/400	38	53	76	106
No. 6	4 to 6	1/25	123	174	246	348
		1/100	73	103	146	206
		1/200	49	69	98	138
		1/400	36	50	72	100
		1/1000	22	32	44	64
No. 6B	4 to 6 (satin finish).	1/25	100	141	200	282
		1/100	56	79	112	158
		1/200	38	57	76	114
		1/400	28	40	56	80
		1/1000	18	25	35	49
No. 11	6 to 7	1/25	145	205	290	407
		1/50	123	173	246	346
		1/100	118	166	236	332
		1/200	89	126	180	252
		1/400	67	95	134	190
No. 22	6 to 7 (satin finish).	1/25	180	255	360	560
		1/50	156	220	312	440
		1/100	134	190	268	380
		1/200	112	158	224	316
		1/400	84	118	168	236
				daylight film	daylight film	
No. 22B	6 to 7	1/25	130	182	260	364
		1/50	110	154	220	308
		1/100	100	141	200	282
		1/200	85	119	170	238
		1/400	60	84	120	168
No. 31		1/25	200	285	403	570
		1/100	78	111	157	220
		1/200	56	79	112	148
		1/400	38	54	76	108
		1/1000	25	35	49	69
No. 50	Medium size studio reflector with satin finish.	1/25	270	380	540	755
No. 50B	Medium size studio reflector.	1/25		daylight film	daylight film	
			200	282	400	564
Press 25	4 to 5	1/50	125	176	250	352
		1/100	95	134	190	268
		1/200-1/250	75	106	150	212
		1/400-1/500	55	77	110	155

Table 8-1. Flashbulb Guide Numbers—Continued

Lamp number	Reflector (The value stated is the diameter in inches of a polished reflector, unless otherwise stated.)	Shutter speed (The guide number of the slowest speed given may be used for slower speeds.)	ASA speed rating (The guide number is for tungsten film unless otherwise stated. Numbers for other ASA ratings can be determined by multiplying the guide number for ASA 100 by 1/10 the square root of the other ASA rating.)			
			25	50	100	200
			Guide numbers (for average scenes)			
Press 40 (as class M).	6 to 7	1/50	150	210	300	420
		1/100	120	170	240	340
		1/200-1/250	90	127	180	254
		1/400-1/500	65	91	130	182
Press 40 (as class FP).	6 to 7	1/200-1/250	65	91	130	182
		1/400-1/500	48	68	96	136
		1/1000	30	42	60	84
SF	4 to 5	1/100	65	92	130	184
		1/200-1/250	46	65	92	130
		1/400-1/500	32	45	64	90
SM	4 to 6	1/100	67	94	134	188
		1/200	62	87	124	174
		1/400	51	72	103	144
	4 to 6 (satin finish).	1/100	54	76	108	152
		1/200	49	69	98	138
		1/400	40	57	80	114

Special purpose flashbulbs		Shutter speed	Film and guide number
Electronic flash (max. output)	LM-33(1)	1/500	Daylight ASA 100, guide number 175.
	LE-17A	1/600	Daylight ASA 100, guide number 360 (est.)
Infrared flashbulbs	No. 5R and Blackout No. 25	1/25-1/50	Standard infrared film, guide number 55.
	No. 22R and Blackout No. 2	1/25-1/50	Standard infrared film, guide number 70.

ASA value if you know the guide number for one ASA value. To find the (new) guide number for a (new) ASA value, multiply the old (known) guide number by the square root of the quotient of the new ASA value divided by the old ASA value, as shown by the following formula:

New guide number =

$$\text{old guide number} \sqrt{\frac{\text{new ASA value}}{\text{old ASA value}}}$$

For example, if the guide number for an ASA of 100 is 50, then the guide number for an ASA of 200 is

$$50\sqrt{\frac{200}{100}}$$

$$50\sqrt{\frac{200}{100}} = 50\sqrt{2} = 50 \text{ x } 1.4 = 70.$$

8-19. Summary of Flash Operation

a. Flashbulbs are usually powered by batteries that should be checked frequently and replaced when old or damaged, even if they have never been used.

b. All wet cells and some dry cells can be recharged.

c. Battery efficiency decreases with temperature.

d. Corroded contacts and broken cables are chief causes of flash failure.

e. Many lamps have a blue spot that turns pink when the lamp is defective.

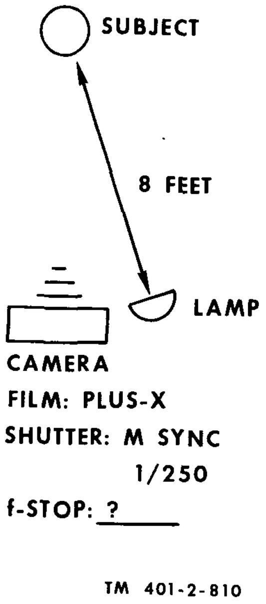

Figure 8-14. Problem to determine f/stop.

f. There are four types of flashbulb bases—screw, bayonet, pinless, and glass.

g. Select a flashbulb for the intensity required for your exposure and to fit your flash holder and reflector.

h. Time-intensity curves show how the brightness of the flash varies during the flash.

i. Class S flashbulbs take about 30 milliseconds to reach peak brilliance, give a lot of light, and are used for open areas and with open flash.

j. Class M flashbulbs reach their peak in 20 milliseconds.

k. Class FP flashbulbs have a long, flat peak for use with focal plane shutters.

l. In the open flash technique, open the shutter before the flashbulb is fired, and close it after the flash is extinguished. In a synchronized flash, delay either the shutter or the flash so that the flash and the open shutter occur at the same time.

m. Electronic flash units are very fast; they stop action, produce cool light, and are good for tens of thousands of flashes.

n. For normal exposure with an electronic flash unit—

(1) The shutter speed is longer than the duration of the flash.

(2) The f/stop equals the lamp guide number divided by the lamp-to-subject distance.

(3) The aperture is opened one f/stop or more to compensate for absorption of some light by the reflecting surface.

Section III. LIGHTING EFFECTS AND EXPOSURE

8-20. Open Aperture for Diffuse or Bounce Flash

a. Except when the flash is mounted on the camera, flash lighting generally is very harsh with strong highlights. To soften the lighting and make it more natural you can use diffusing or bounce techniques.

b. To diffuse the flash you can use a diffusing reflector, a diffusing shield, or simply place a standard man's cotton handkerchief over the flash. A diffusing reflector has a rough surface, while the polished reflector has a smooth mirror finish. The diffusing shield is a piece of translucent plastic that fits over the front of the reflector.

c. Each of the above mentioned diffusing devices reduces the intensity of the light by about one-half; thus, you must open the lens one additional stop.

d. You must also open the lens for bounce flash. Bounce flash is the technique of reflecting the light off a wall, ceiling, or other surface to get a diffused or more natural lighting of the subject. To determine the lens opening with bounce flash, use the distance that the light travels to the subject. That is, the distance from the lamp to where the light hits the wall plus the distance from where the light hits the wall to the subject (fig. 8-15).

8-21. Flash-on-Camera Gives Flat Lighting

a. Mounting the flash on the camera is a convenience that gives the photographer freedom of movement and ability to make exposures quickly with assurance of fairly good lighting. However, do not limit the quality of your photographs by becoming lazy and using flash-on-camera techniques exclusively.

b. Flash-on-camera gives flat lighting. There are no shadows in the picture because the flash illuminates almost every area that can be seen by the camera. Shadows give depth to the picture and body to the subject. Without shadows the photograph loses some of its ability to produce the optical illusion of the three dimensions, and consequently it appears flat.

c. Because illumination decreases with the square of the distance, flash-on-camera is likely to result in overexposure of near objects and underexposure of far objects.

d. Flash-on-camera is best used as a secondary

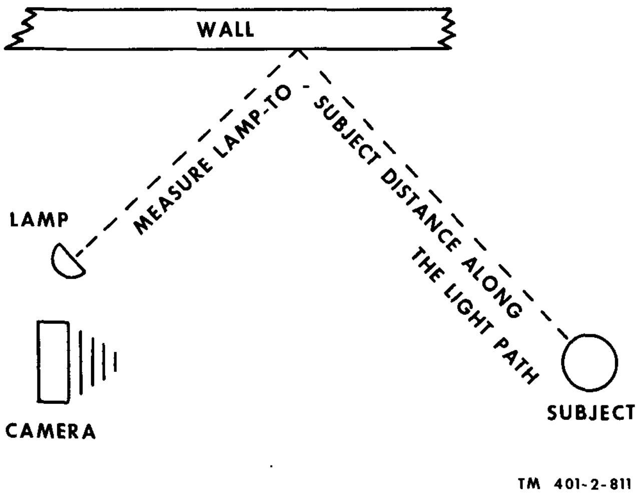

Figure 8-15. Lamp-to-subject distance.

or fill-in light to bring out the details in shadows created by a key light that is off to one side.

8-22. Flash Off to One Side Gives Form

a. Lighting the subject from one side produces shadows that the camera records, and these shadows create the illusion of depth, form, and texture. The light should not be directly to one side of the subject but somewhere between head on and to one side. Even holding the flash at arms length to one side of the camera will improve the quality of the photograph.

b. Another advantage of having the light off to one side is that it will give a more even illumination of deep scenes. If you place the light off to one side, the distance from the light to the front of the scene is about the same as the distance from the light to the back of the scene. When the scene is very deep use more than one light.

c. Flash can also be used as separation light, to light the background, or to silhouette the subject.

d. The disadvantage of side lighting is the loss of detail in shadow areas, but you can overcome this by using multiple flash.

8-23. How to Adjust Exposure for Multiple Flash

a. Flash off to one side (key lighting) gives form and texture to the photograph; flash on the camera (fill-in lighting) brings out shadow details; and lighting the background or back of the subject (separation lighting) separates the subject and the background giving depth to the picture. You can take advantage of all these forms of lighting in one photograph by using many flashbulbs. In a synchronized multiple flash, all the lamps must fire at the same time and you'll need a strong power source. Using the technique of open flash, you can make the exposure by firing one flashbulb at a time.

b. Additional flashbulbs increase the light level; therefore, you should decrease the lens opening. However, it is not necessary to make any exposure adjustment for separation lights. Separation lights are never (except for pure silhouettes) used as the primary lighting, and the amount of increase in total light level is small.

c. When you use more than one lamp in about the same position to get an increase in amount of light, use the same type of flashbulb for all lamps. The proper guide number to use for the sum of all the light is equal to the guide number of one flashbulb multiplied by the square root of the number of lamps. For instance, if you use two lamps whose individual guide numbers are 50, the guide number for both flashbulbs together is 50 times the square root of 2 ($\sqrt{2}=1.4$) or 70. *Another example;* when you use three flashbulbs whose guide numbers are each 35, the guide number for the total light is 35 times the square root of 3 ($\sqrt{3}=1.74$), which equals approximately 61.

d. When using many flashbulbs to illuminate scenes of great depth, set the aperture to an opening that will provide the desired depth of field; then position the lights for even illumination as follows. The area lighted by each lamp should slightly overlap the area lighted by adjacent lamps. The lamp-to-subject distance of each lamp is equal to the guide number divided by the f-number, which was determined by the depth of field. All the lamps should be pointed in the same direction to give the effect of a single source of light (fig. 8-16).

e. When you use more than one flashbulb to light from different angles, the exposure adjustment depends on the lighting ratio.

8-24. Lighting Ratio is Highlight to Shadow

a. The lighting ratio is the ratio of the illumination of the highlights to the illumination of shadows. The lowest possible ratio (1:1) means that the highlights and shadows are lighted to the same extent. At 2:1 the highlights have twice the light of the shadows; at 3:1, three times the amount; and so on (fig. 8-17).

b. A lighting ratio of 1:1 is used principally for copying or where any shadow is undesirable. To get a 1:1 ratio requires a careful balancing of lights so that there are no shadows and so that the lighting is the same throughout.

c. A lighting ratio of 2:1 results in faint shadows with high detail in the shadows. The bright

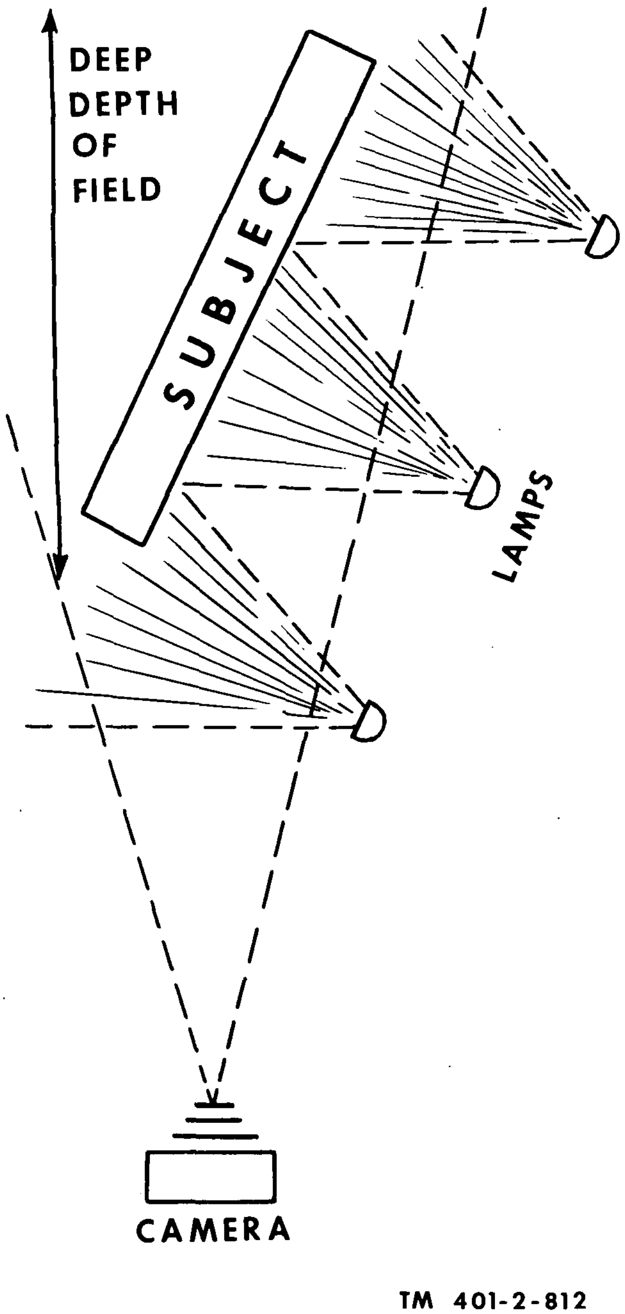

Figure 8–16. Lighting great depths.

shadows of a 2:1 ratio retain color purity in color film, permit good rendition of mechanical objects, and reduce the burned out effect of highly reflective highlights. The 2:1 ratio is obtained by using equal lights from key and fill-in lights. Even though they are of equal intensity, the highlights will be brighter because they receive light from both lamps, whereas the shadow areas are illuminated only by the fill-in light.

d. A 3:1 lighting ratio is the result of having the key light supply twice the illumination of the fill-in light (fig. 8–17). The shadow areas are very noticeable without too much loss in shadow details. The 3:1 ratio is good for most black and white pictures, especially activity shots and portraits.

e. As the lighting ratio increases, the shadow area gets effectively darker and darker, and, depending on the latitude of the film, the shadow details are soon lost completely. The higher ratios are used for dramatic effects.

8–25. How to Get a 2:1 Lighting Ratio

a. Position the key and fill-in lights so that each illuminates the subject with the same intensity.

(1) If the same size lamps are used place them at the same distance.

(2) If different size lamps are used place them at distances that will put the same amount of light on the subject. This can be done by dividing the fill-in lamp guide number by the f/number determined by the key light to find the proper fill-in lamp distance.

b. Determine exposure by dividing the *key lamp* distance into the guide number for that lamp. Examples are—

(1) If two number 5 lamps, each having a guide number of 160, are used, place them equal distances from the subject and divide 160 by that distance to find the f/stop.

(2) If two different size lamps are used, one with a guide number of 160 and another with a guide number of 220, use the larger lamp for the key light and divide 220 by its distance to find the f/stop. If it were at 10 feet, you would use $\frac{220}{10}$ $=$f/22. Next, divide the fill-in light guide number of 160 by f/22 to find a fill-in lamp distance of $\frac{160}{22}$ $=$7.3 feet (fig. 8–18).

8–26. How to Get a 3:1 Lighting Ratio

a. Place the lamps so the key light strikes the subject with twice the intensity of the fill-in light. This may be done by—

(1) Using the same size lamps with the key light ⅓ closer than the fill-in light;

(2) Using same size lamps at the same distance with one thickness of a handkerchief over the *fill-in* light;

(3) Using a lamp twice the intensity for a key light and another as the fill-in light at equal distances. For this purpose a # 2 lamp can be used as the key with a #5 for the fill-in light.

b. Determine exposure by dividing the *key lamp* distance by its guide number.

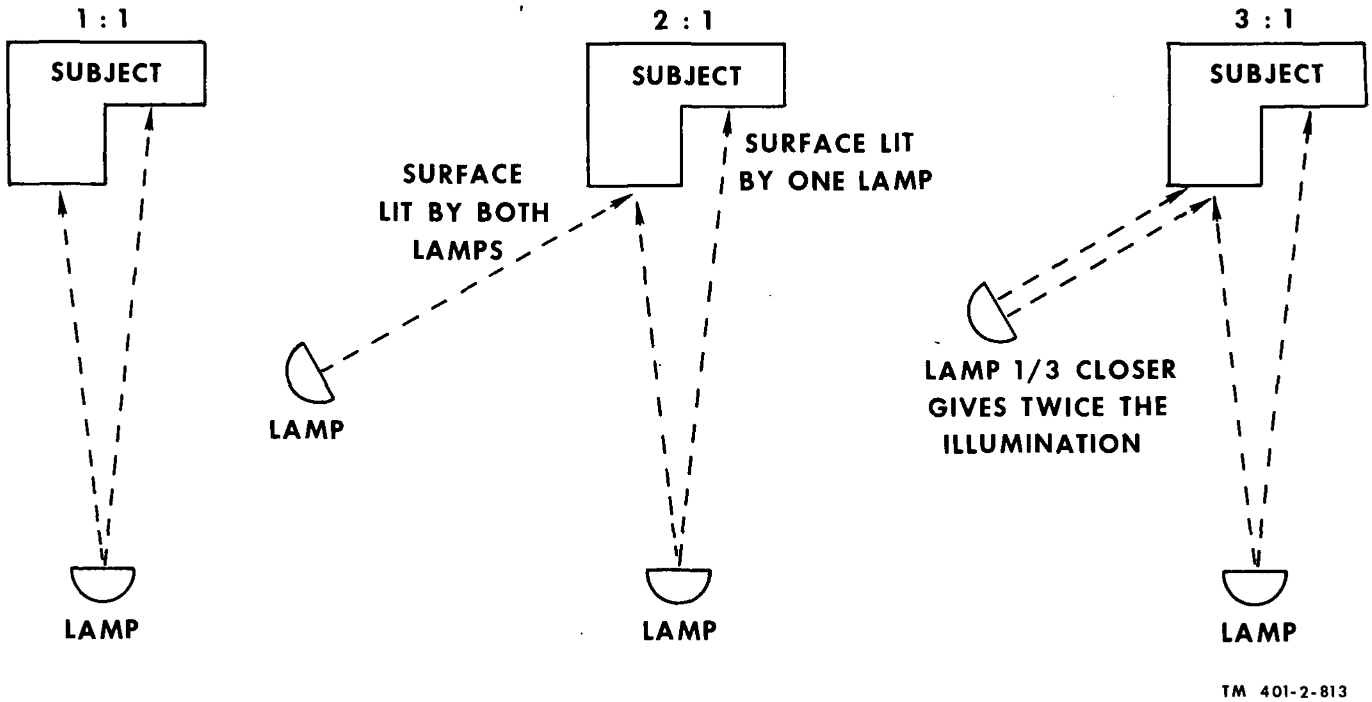

Figure 8–17. Lighting ratios.

8–27. How to Change Lamp-to-Subject Distance

a. Using the formula for distance (para 8–25*b* (2)) to position a lamp for the proper lighting may place the lamp in a poor or impossible position. A long distance might require placing the lamp on the other side of a wall or some other obstruction. A short distance might mean placing the lamp in the view of the camera. Consequently, you need to know how to change the lamp-to-subject distance without changing the lighting. There are many ways to do this.

b. One method to change the lamp-to-subject distance is to use different flashbulbs. Use flashbulbs with larger guide numbers for greater distance and lower guide numbers for lesser distance. The guide number of a lamp increases with film speed; thus, using faster film will also increase the lamp-to-subject distance.

c. Changing the lens opening changes the lamp-to-subject distance. Either divide the distance and multiply the f-number by the same value, or multiply the distance and divide the f-number by the same value. *For example,* if the lamp is set at 10 feet for f/4, then the distance could be reduced to 5 feet by using f/8.

d. You can reduce the lamp-to-subject distance by using handkerchiefs over the flashbulb. When using one, divide the distance by the square root of two. For two handkerchiefs over the flashbulb, cut the distance in half.

e. You can reduce the direct line distance by using bounce flash or tilting the reflector. Bounce flash will not alter the lamp-to-subject distance because the distance is measured along the light path. Tilting the reflector reduces the effect of the light.

f. You can also alter the amount of exposure by changing the shutter speed. Remember, however, that the shutter speed only affects the exposure when the speed is shorter than the flash duration, and that the amount of effect depends on the flashbulb's time-intensity curve.

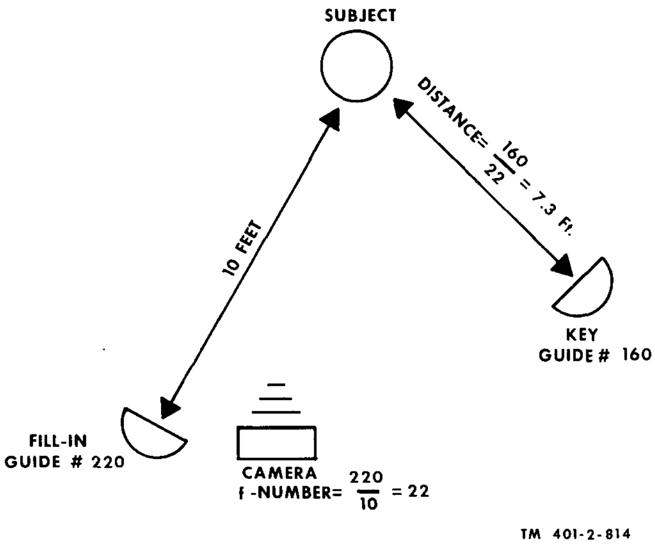

Figure 8–18. Determining 2:1 lighting ratio.

g. You can decrease the exposure by using the appropriate corrective filter for black and white or a neutral density or polaroid filter for color. Divide the guide number by the square root of the filter factor.

8-28. Use of Flash in Daylight

Night and indoor shots are not the only situations when you use flashbulbs. You might use them to replace one or more photoflood lamps. Perhaps you might use photofloods for fill-in and separation light, while using the flash as a main light to reduce the strain on the subject caused by the bright lights. You can use flashbulbs in sunlight to lower contrast, increase shadow detail, and add brilliance. On dull, overcast days you might get flat, uninteresting pictures, but if you use a flash it can add sparkle, form, depth, and sharpness to a photograph taken on a dull day. On a bright, clear day the sun creates deep, dark shadows. A flash can lighten the shadows, bring out details in the shadows, and reduce the overall contrast to remove the cutting sharpness of a bright day.

8-29. Use Sun as Key Light on Bright Day

a. On bright, sunny days use the sun as the key light and the flash as a fill-in light.

b. For a 2:1 lighting ratio, adjust your exposure for a front-lighted scene using the daylight chart in TM 11-401-1, chapter 6. Place the flashbulb on the shadow side of the camera but not way out to the side. Use the following formula to determine the lamp-to-subject distance:

$$\text{distance} = \frac{\text{guide number}}{\text{f-number}}$$

c. For a 3:1 lighting ratio, proceed as for a 2:1 ratio (*b* above), but either diffuse the flash or place it one-third of the distance farther away from the subject.

8-30. Use Sun as Fill-in on Dull Day

a. On dull, overcast days use existing light as a fill-in light and flash as the key light. Set your exposure for the type of daylight, and then position your flash to simulate the sun.

b. For a 2:1 lighting ratio use the formula in paragraph 8-29*b* to determine the lamp-to-subject distance.

c. For a 3:1 lighting ratio use the above formula (para 8-29*b*) to determine the lamp-to-subject distance. Then move the lamp one-third closer and stop down one f/stop.

8-31. Use Flash to Balance Sun

a. When you photograph indoors where the bright daylight is visible through a door or a window, and when you photograph in deep shade where bright patches of sunlight are visible, the extreme variation of lighting may be too much for the film. These situations are easily handled by the human eye, but the resulting photograph is so dark in the shade areas and so white in the sunlit areas that the details of both are lost. To overcome this effect and get an indoor-outdoor balance, you can use a flash to lighten the shady area (*b* below).

b. Set the exposure as though the entire scene were receiving the same light as the sunlit areas, and position the flashbulb according to the formula in paragraph 8-29*b*. You may need more than one lamp to get even lighting throughout the entire indoor or shaded area. No exposure adjustment is necessary for the additional lamps if there is no excessive overlapping of the light, and if you use the distance formula for each flashbulb.

Section IV. SUMMARY AND QUESTIONS

8-32. Summary of Flash Techniques

Table 8-II summarizes the information presented in the last few paragraphs by comparing the photographic effect with the technique used. In each comparison the *Exposure adjustment* column tells how to adjust the exposure from the normal.

8-33. Final Summary

a. Electricity from a power source, usually a battery, ignites a metal in the flashbulb, thereby producing a bright light.

b. Time-intensity curves show how the brilliance of a flashbulb varies with time.

c. Class S flashbulbs take a long time to reach their peak; class M take about 20 milliseconds.

d. Class FP flashbulbs have a long, flat peak and are used with focal plane shutters.

e. Speedlamps or electronic flash lamps have no delay; the flash, a daylight color, is over in less than 1/500 second.

f. In the open flash technique, open the shutter, fire the flashbulb, and close the shutter.

g. In normal synchronized flash, delay opening the shutter until the flash has started.

h. In X synchronization delay the flash until the shutter is open.

Table 8–II. Flash Techniques

Effect	Technique	Exposure adjustment
Normal	Single lamp synchronized or open flash.	Shutter speed—longer than flash duration $\text{f-number} = \dfrac{\text{lamp guide number}}{\text{lamp-to-subject distance}}$
Reduce harshness	Diffuse flash	Open one stop.
	Bounce flash	Calculate lamp-to-subject distance along light path.
Flat picture, no shadows	Flash-on-camera	Normal.
Even illumination with shadows.	Flash off to one side	Normal.
Deep scene illumination	Multiple flash	Set f/stop for depth of field. Place lamps so there is no excessive overlap of light, and use normal f-number formula to determine lamp-to-subject distance.
Increased light	Multiple flash	Divide normal f-number for one lamp by the square root of the number of lamps. Use same type of lamps and place the lamps in the same position.
Decreased light	Filter	Divide the guide number by the square root of the filter factor.
High shadow detail	2:1 lighting ratio	Set for normal exposure using fill-in lamp. Set key lamp distance by normal f-number formula.
Fair shadow detail	3:1 lighting ratio	Set for 2:1 ratio and do one of the following: (1) Place handerkchief over fill-in lamp. (2) Move key lamp ⅓ closer.
Lighten shadows	Use flash as fill-in light.	Set f/stop by daylight exposure chart. Set lamp distance by normal f-number formula. Open one f/stop to compensate for light absorption.
Brighten scene on dull day	Use flash as key light.	Set for normal exposure in daylight. Set key lamp distance by normal f-number formula.
Indoor-outdoor balance	Use flash to light the indoors.	Set exposure for sunlit area. Set flash for the same illumination in the dark areas.
Move lamps closer	Use weaker lamps	Recalculate.
	Use slower film	Recalculate.
	Close down lens	Multiply normal calculated f-number by the ratio of the old distance to the new distance.
	Cover lamp with 1 handerchief.	Move lamp ⅓ closer.
	Cover lamp with 2 handerchiefs.	Move lamp ½ closer.
	Use bounce flash	Recalculate using light path as lamp-to-subject distance.
	Increase shutter speed.	Depends on the lamp's time-intensity curve.
	Tilt reflector	Estimate; there are no specific rules.
Move lamps farther away	Use more than one lamp.	Use the same type of lamps and recalculate using the guide number of one lamp divided by the number of lamps.
	Use stronger lamps	Recalculate.
	Use faster fiilm	Recalculate.
	Open up lens	Multiply normal calculated f-number by the ratio of the new distance to the old distance.

i. The shutter speed is normally longer than the duration of the flash, but with the use of charts or graphs of the flashbulb's characteristics you may increase the shutter speed.

j. Determine the proper f/stop by dividing the flashbulb guide number by the lamp-to-subject distance in feet.

k. The guide number of a lamp depends on the scene brightness, the reflector, the film speed, and the lamp's construction.

l. Flash-on-camera is flat; flash off to one side gives form; and diffuse or bounce flash gives softness.

m. The lighting ratio is the ratio of highlight to shadow light.

n. To get a lighting ratio of 1:1 use equal light from both sides; to get a ratio of 2:1 apply the formula—

$$\text{f-number} = \frac{\text{guide number}}{\text{lamp-to-subject distance}}$$

to both key and fill-in lamps; to get a ratio of 3:1, use 2:1 and either diffuse the fill-in lamp or move the key lamp one-third closer.

o. Use the sun as a key light on a bright day with the flash as a fill-in light.

p. Use the sun as a fill-in light on a dull day with the flash as the key light.

q. Use the flash to balance the sunlight when the scene is very dark but includes bright sunlit areas.

8–34. Review Questions

a. Can any type of battery be used to fire a flashbulb?

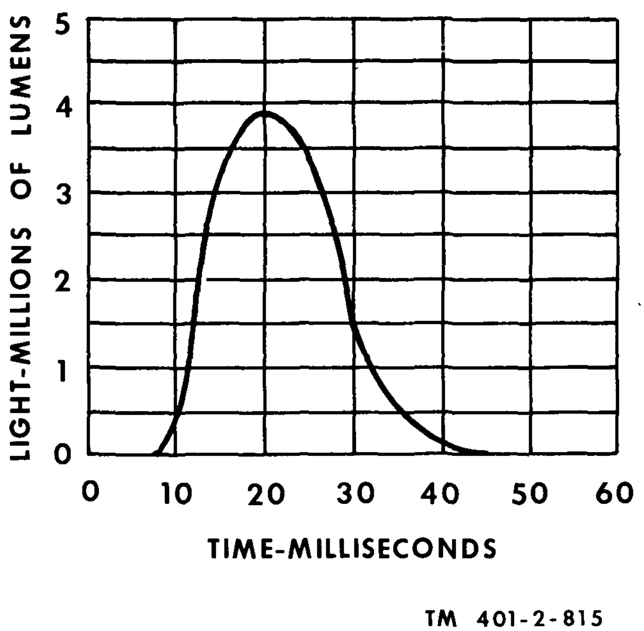

Figure 8–19. A time-intensity curve.

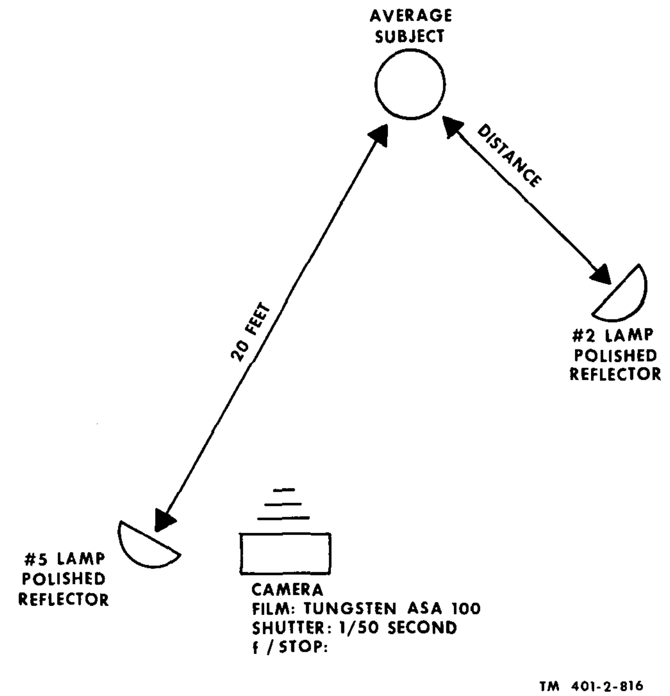

Figure 8–20. A lighting setup.

b. The efficiency of a battery drops with temperature. Approximately how much efficiency is lost when the temperature is freezing?

c. Name four types of flashbulb bases.

d. Use figure 8–19 to answer the following questions.

(1) What is the class of this flashbulb?

(2) Assuming the shutter opening is not delayed, to use full flash would require a shutter speed of at least -------- second.

(3) Which of the following types of synchronization would be used with this flashbulb? None, solenoid, or X.

e. What type of synchronization is used with speedlamps?

f. What f/stop is used in the flash-on-camera technique with a lamp guide number of 128 at a distance of 8 feet?

g. If the guide number is 70 for an ASA rating of 100, what is the guide number (of the same lamp) for an ASA rating of 400?

h. Use figure 8–20 and table 8–I to answer the following questions:

(1) What f/stop should be used?

(2) What is the lamp-to-subject distance of the #2 lamp for a lighting ratio of 2:1?

(3) How far and in what direction is lamp #2 moved to change from 2:1 to a 3:1 lighting ratio?

(4) State two other methods of getting a 3:1 lighting ratio.

8-35. Answers to Review Questions

a. Yes, if it's proper size, but batteries designed for firing flashbulbs are more dependable.

b. 50%

c. Screw, bayonet, pinless, and glass.

d. (1) M.

(2) 1/25 (must last at least 40 milliseconds).

(3) Solenoid.

e. X.

f. f/16 $\left(\frac{\text{guide number}}{\text{lamp-to-subject distance}}=\frac{128}{8}=16\right)$

g. 280 (old guide number x $\frac{\text{new ASA}}{\text{old ASA}}$

$=70 \text{ x } \frac{400}{100}=70 \text{ x } 4=280$).

h. (1) f/11 $\left(\frac{\text{guide number}}{\text{lamp-to-subject distance}}\right.$

$\left.=\frac{224}{20}=11.2\right)$.

(2) 33 ft $\left(\frac{\text{guide number}}{\text{f-number}}=\frac{360}{11}=33\right)$.

(3) 11 feet toward subject.

(4) Place handkerchief over the fill-in light. Multiply the fill-in guide number by 1.4, and recalculate the f/stop and key lamp-to-subject distance.

CHAPTER 9

COLOR PHOTOGRAPHY

Section I. SOME FACTS ABOUT COLOR

9-1. Introductory Information

a. Color brings life, realness, and depth to a picture more than any other photographic phenomenon. Color is natural because we see in color. Even though black and white film is sensitive to the frequency of the light, the shades of gray it produces do not clearly indicate color. For instance, it is possible for black and white film to produce exactly the same shade of gray for green and orange, thus hiding oranges in the trees. Color aids in identification—the girl in the *red* dress. Color can show condition—the *green* and ripe *red* apples. And color can set a mood—a *blue* day.

b. You do not need a special camera to produce color pictures because color film is made in sizes to fit practically all cameras. Actually, the whole process is much the same as producing black and white photographs. Still, there are some differences. In this chapter we'll discuss these differences and explain how you, the photographer, must extend your rules of composition, how you select film and filters, and how you must be attentive to the color of the light source.

9-2. No Light—No Color

a. Without light there is *no* color. In a very dimly lit room all objects are various shades of gray. Is gray a color? Gray is a degree of whiteness or a degree of blackness. Black is no light; thus, no color. White light is all colors mixed together. Gray is a dark white or a stage between white and black, but not a single color.

b. Color is in the light, so let's look at the light sources (sun, electric lights, fire, etc.). Most light sources produce light as radiant energy with many different wavelengths. Each wavelength is a different color, but when the wavelengths are seen together in the proper proportion the result is white light. Seldom does the source produce *pure* white light—the sun has more yellow-orange light than other colors, electric lamps more orange, fluorescent lamps more blue, and fire more red.

9-3. Blue, Green, and Red are Primary Colors

a. White light includes all the wavelengths between about 400 and 700 millimicrons and could be divided into thousands of colors. To simplify explanation, because of the sensitivity of our eyes, because it's all that is necessary for our purposes, and for other reasons, we consider white light as the sum of three primary colors—blue, green, and red.

b. The color of an object is the color of light that the object reflects (fig. 9-1). When an object with white light shining on it looks red to our eye, it's because the object reflects the red light and absorbs the blue and green light. Blue objects absorb the green and red and reflect the blue light, while green objects absorb the blue and red of the white light and reflect the green. In red light, an object that reflects only blue looks black to us because there is no blue in the red light for the object to reflect.

c. Blue, green, and red are called additive colors. That is, by adding together light of these colors in various proportions, you can produce other colors; in fact, you can make practically any color (fig. 9-2). White light shining on an object that absorbs only blue looks yellow because yellow is the sum of the green and red light that is reflected. When you add light—

Green + Red + Blue = White
Green + Red = Yellow
Green + Blue = Cyan
Red + Blue = Magenta

d. Yellow, cyan, and magenta are called the secondary or subtractive colors. Subtracting a secondary color from white light leaves a primary color (fig. 9-3). When you subtract light—

White-Yellow = Blue
White-Cyan = Red
White-Magenta = Green
White-any 2 secondaries = Black

9-4. Color Changes With Hue, Intensity, and Saturation

a. So far we've been discussing the basic color, also called the *hue* or tint. But the basic wavelength isn't the only determinant of the color of light. The light may also vary in *intensity* and *saturation,* and these two factors also affect the appearance of color.

b. As the intensity or brightness of the light decreases, the color appears darker (blacker),

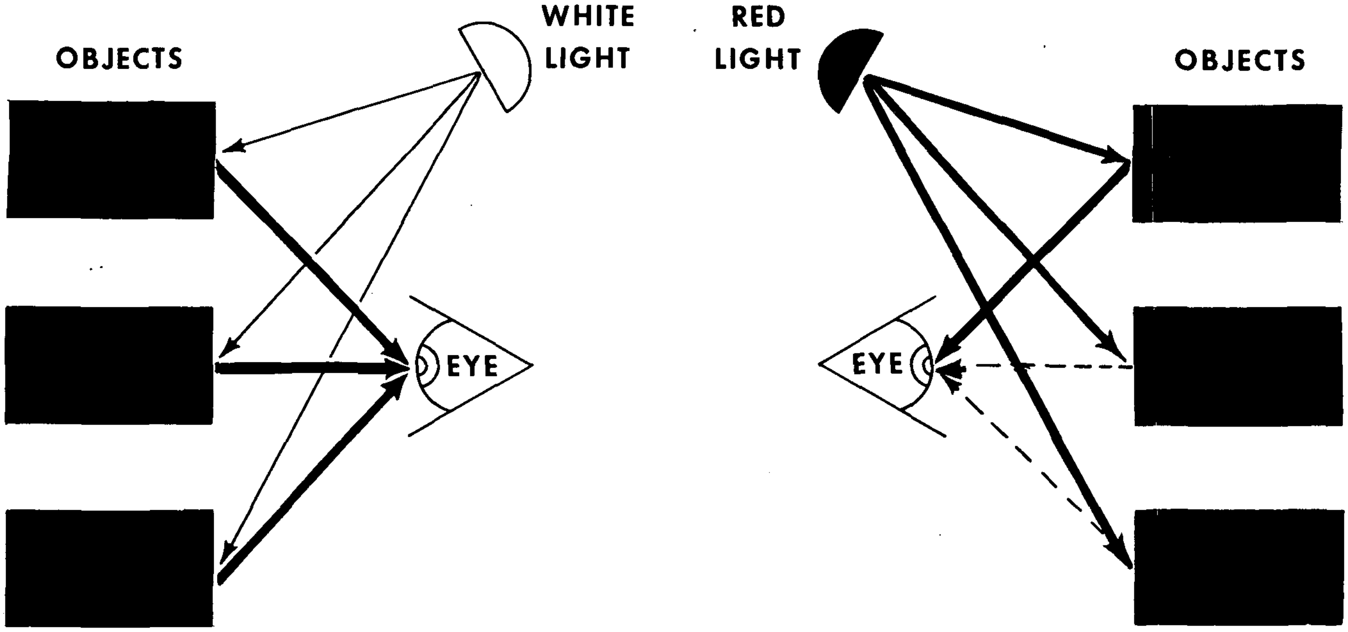

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Figure 9–1. Color of an object.

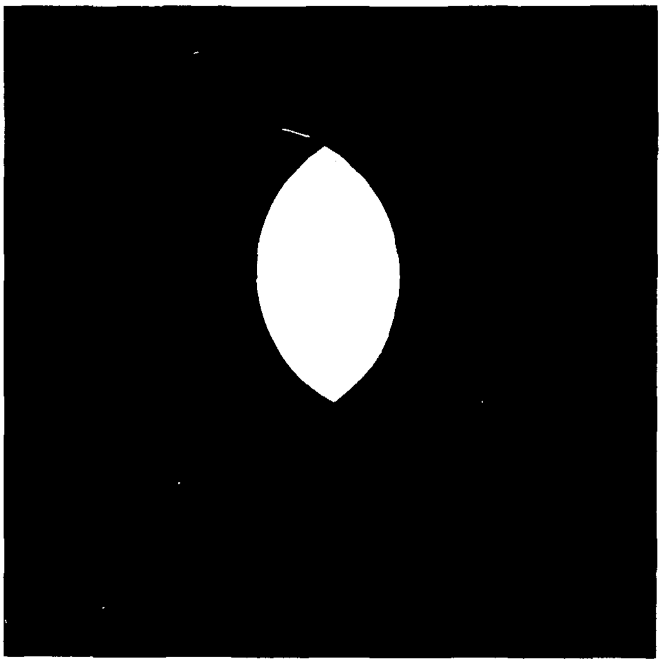

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Figure 9–2. Color addition.

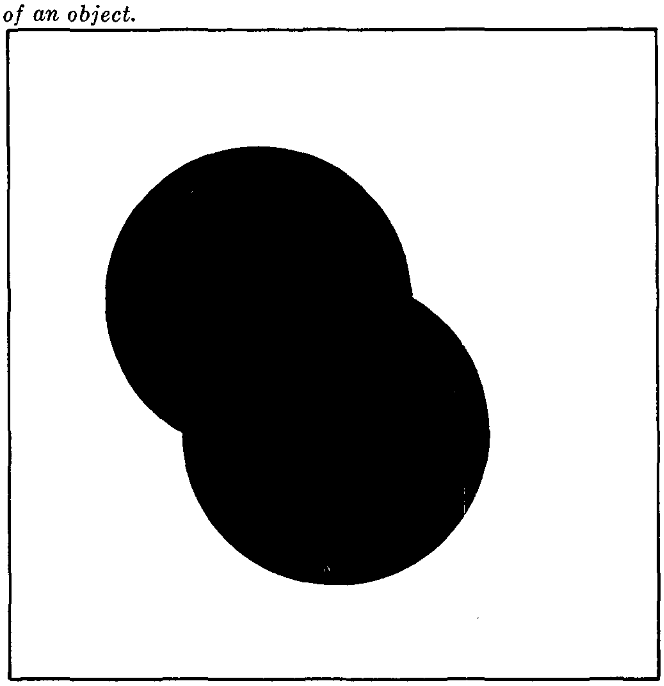

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Figure 9–3. Color subtraction.

and as the intensity increases, the color becomes lighter (whiter). *For example,* increasing the brightness of red makes the color more vermilion or fire engine red, and decreasing the brightness seems to add a brown or black to the color changing red to ruby.

c. The saturation or purity of the color refers to the amount of gray, the impurity, mixed with the color. A pure color is called a highly saturated color and has no gray. The more gray, the less saturated (pure) is the color. Highly saturated colors are sharp, vibrant, contrasty, and they stand out. Unsaturated colors, containing gray, are dull and washed out, and they blend with other unsaturated colors.

d. In summary, we can say that the color of an object depends on the wavelengths emitted by the light source, the intensity of the light source, and the amount of saturation. It also depends on the absorbing and reflecting power of the object, the color sensitivity of our eyes, and, most important, the mental process that interprets what we see. We'll base most of the rules for composing color photographs on the mental process.

9-5. Keep Color Composition Simple

a. Rules for composition *cannot* be hard-and-fast laws that are strictly enforced. If they were, all pictures would look alike and be very boring. The rules are actually guides; how closely you apply them may vary with each snap of the shutter.

b. All the rules for composing black and white photographs also apply to color pictures.

c. Color photographs should have simplicity of color as well as theme. A picture that has many different colors is hard on your eyes. This is especially true if the colors are bright and highly saturated. We are *not* saying to use only one color; normally you'll want a number of colors to provide contrast. In color, as in black and white, you want contrast, but you do not want the picture to be too varied.

d. For simplicity, use one or two pure colors for the center of interest or principal subject, and use unsaturated colors for the rest of the picture. You should use a saturated color for the center of interest because pure color attracts attention more than the dull, unsaturated ones.

9-6. Use the Complement for Contrast

a. To make the subject stand out, use the subject's complementary color for the background. Recall that a complement is the color you get when you subtract a color from white; or, put another way, the sum of a color and its complement is white. The complements are—

(1) Blue and yellow.
(2) Red and cyan.
(3) Green and magenta.

b. Equally bright and saturated complements, side by side, appear vibrant and harsh. Thus, unless you want a hard, striking contrast, you should have an unsaturated background color. The background should also be lighter or darker than the subject. A bright background makes the subject look darker, and a dark background makes the subject look lighter. The apparent lightening and darkening is so dramatic in some cases that a single patch of color can appear as two shades if it overlaps two very different backgrounds. *For example,* a patch of blue may look much darker where the background is yellow than where the background is black.

c. An important place to use complements is in signs. You need a high contrast in signs to make words or letters legible, and since complements show contrast they are desirable. However, just using two different colors is not always enough. Physical characteristics other than color, such as shape or texture, may cause our eyes to separate colors that the film cannot.

9-7. Beware of Color Reflections

a. Sometimes we can see what the camera cannot, but more often it's the other way around—the camera sees what we do not. *For example,* suppose our eyes receive an image of a man with a green tinted face. Quickly our brain evaluates the situation, decides that the green tint is actually light reflected from nearby trees, and cancels the green tint, so that our mental impression is the face of a man with normal flesh tones. But the camera will see and record the man with a green face. Unless the cause of the green appears clearly in the picture, people viewing the photograph will see the green face without understanding its cause.

b. Reflection falling on the subject of the photograph from a brightly colored object is like illuminating the subject with a colored light. There will be a color change in the subject, especially if the subject is white, light gray, flesh toned, or in the shade. Be aware of these color reflections. Avoid them, block them, or include the source in the picture. A color change due to reflected light is acceptable if the picture clearly shows the cause of the color change.

c. To prevent a change of color because of reflected light, you can either move the subject or move the camera. You can also place a screen between the subject and reflecting object, move the reflecting object, or cover the reflecting surface.

9-8. Color Has Meaning

a. Colors express mode and mood. Cleverly using color will help bring out the thought behind your photograph. However, because all people do not react exactly the same to colors, *do not* accept the following color meanings as firm, hard facts. Use them as guides in planning better photographs.

b. Red depicts anger, excitement, danger, passion, and heat. Red stands for communism. Red is an advancing color. If you place two like objects, one red and the other blue, an equal distance away from the viewer, the red one looks closer and the blue one looks farther away.

c. Blue portrays quiet, cold, sadness, and truth; it is a receding color.

d. Green is relaxing and makes objects look lighter. Yellow-green gives a sickening appearance.

e. Black is depressing and may give an impression of death or disaster.

9-9. Framing is Critical in Color Pictures

a. The frame (the edge of picture area, not the white border) for your photograph should be a neutral, unsaturated color so it does not detract from the scene.

b. In taking black and white pictures, we sometimes photograph an area slightly wider than we desire just to be sure we include all that is necessary. If we include too much, the outer edges of the picture are easily removed during printing. This is not always possible with color film because the film you put in your camera often becomes the final positive product rather than a negative. In photographing with colored film, therefore, framing is more critical. The framing must be correct at the time of the exposure if the film is to become the final product.

c. The fact that color film can become a positive indicates that there are processing differences between color and black and white film. There are two general types of color film and reproduction—additive and subtractive. Additive color processes are being used less and less, because of the generally superior results of subtractive color film. We'll discuss both of these processes so you'll know how each works.

Section II. COLOR FILM

9-10. Additive Color Film Process

a. Additive color film is a panchromatic emulsion covered with a combination color filter. The filter layer of the film is a surface of many minute individual red, green, and blue filters side by side, so small they are invisible to the eye (fig. 9-4). During exposure, light from the scene passes through the filter layer to expose the panchromatic emulsion. The emulsion behind each individual filter is exposed only if light of the filter color hits that spot.

b. You develop the film in black and white developer so that the exposed areas become opaque. You may fix the film in hypo at this time to form a negative. White light shining on the

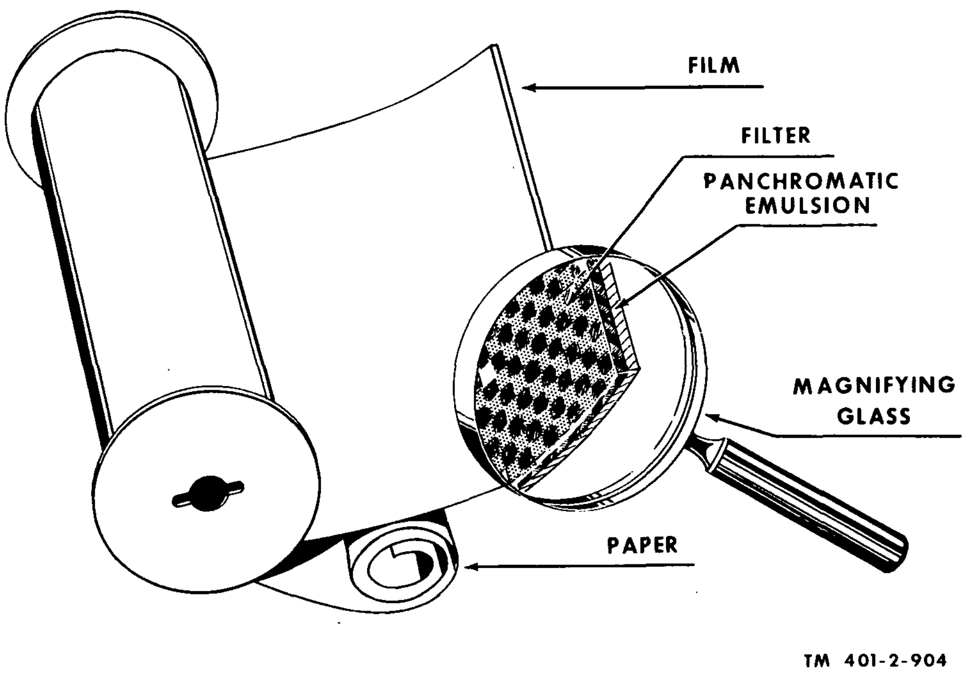

Figure 9-4. Additive color film.

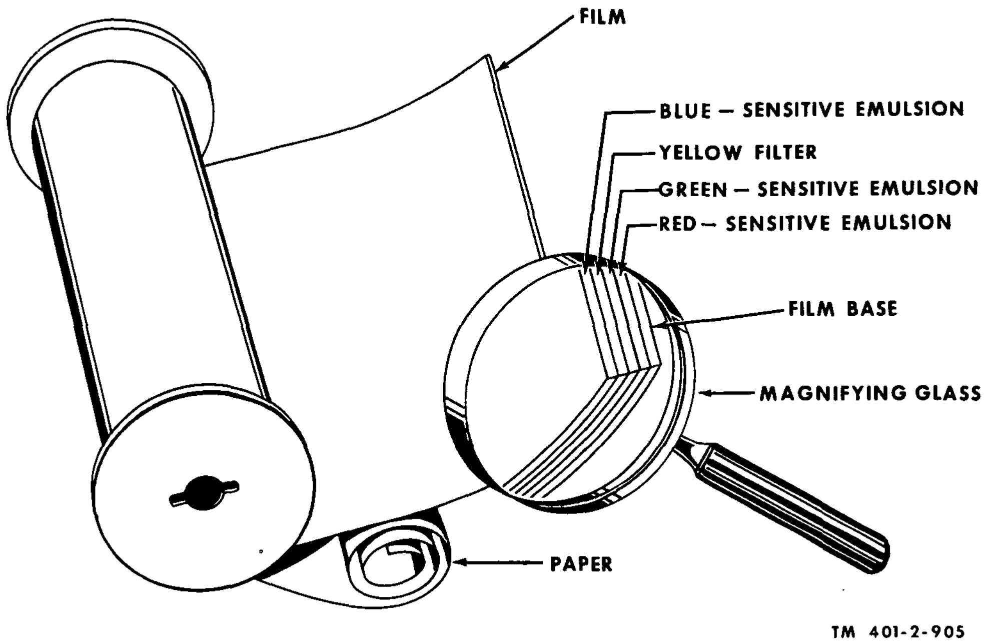

Figure 9-5. Subtractive color film.

back of the negative would come through the unexposed (translucent) areas of the emulsion and be filtered by the filter layer. Because the individual filters are so small, light from adjacent filters will add together, and you will see in the negative the complementary colors of the original scene.

c. To form a positive transparency, you clear the opaque areas by bleaching just after the film is developed, leaving the remainder of the emulsion still sensitive to light. Then expose the film to white light and redevelop it. Thus, the clear areas become opaque and opaque areas become clear, changing the film from a negative to a positive.

d. The additive part in the title of this process applies when you view the film. The rays of light coming through each filter are either red, green, or blue. When the eye sees two rays of light very close together it adds them, and you see the sum rather than the individual rays. If the picture were enlarged enough you would be able to see the individual areas of red, green, and blue.

9–11. Subtractive Color Film Process

a. Subtractive color film is a three-layer emulsion. One layer is sensitive to blue light, one to red light, and one to green light. And because all emulsions are sensitive to blue, a yellow filter is used to prevent blue light from reaching the red- and green-sensitive emulsions (fig. 9–5).

b. A positive transparency is produced by a reversal process than includes developing the film with black and white developer, reexposing to white light, developing in color developer, and bleaching. Developing with black and white developer produces a negative image (black and white) and deactivates the unexposed part of the film. Exposure to white light activates the remaining, undeveloped emulsion. Color development makes the activated part of the blue-sensitive layer blue-absorbent (yellow), the activated part of the green-sensitive layer green-absorbent (magenta), and the activated part of the red-sensitive layer red-absorbent (cyan). The bleach removes the opaque silver, leaving three separate colored images. Each colored image acts as a filter that subtracts some color from white light trying to shine through the transparency (fig. 9–6).

c. You could use the same film to produce a negative by skipping the first part of the reversal process (*b* above) and going directly to the color developer. The areas exposed to blue light turn yellow, the areas exposed to green light turn magenta, and those exposed to red light turn cyan. The developed film becomes a color negative and contains the complements of the original colors.

9–12. How to Select Color Film

a. Select the color film to use on an assignment according to your camera's type and size, the processing materials available, film speed, final product desired, and light source. Table 9–I is a list of common color films.

b. Naturally you'll have to use a film that fits your camera's format size. Whether the camera

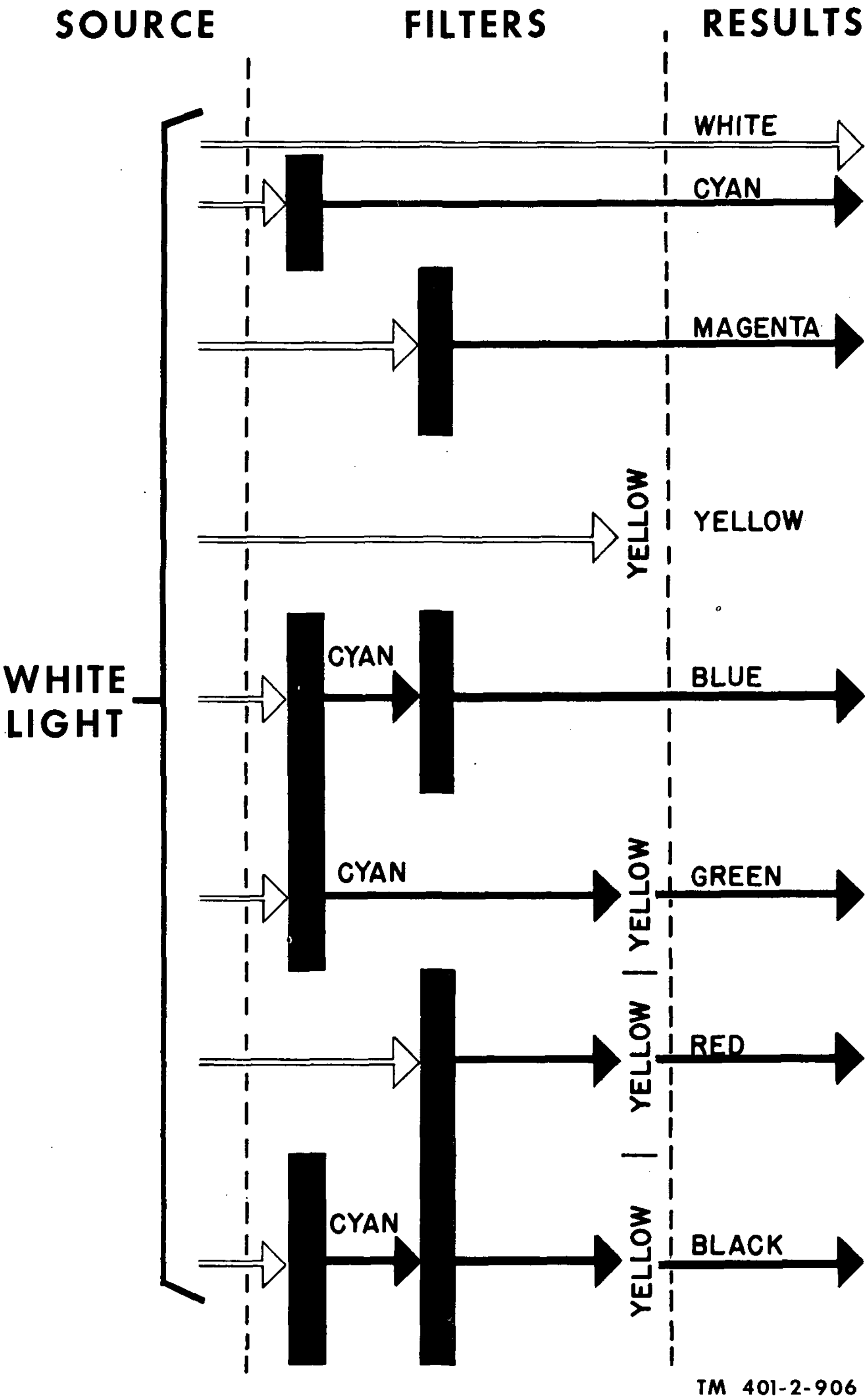

Figure 9–6. How subtractive color film works.

uses sheet or roll film is also a determining factor.

c. Different processing techniques and chemicals are used for different types of color film. Although you can sometimes get satisfactory results when the processes are interchanged, it is always best to use the film manufacturer's recommended process. If your laboratory is restricted in its processing, you will be restricted in film type.

d. Color film speeds are generally slower than black and white; however, the effects of the different speeds are the same. The slower speeds

Table 9-I. Common Color Film

This list of common color films is for your general information only; commercial names are descriptive and do not constitute endorsement. Before using a film that you are not thoroughly familiar with, carefully read all data packaged with the film.

Light	Product	Film	Speed	Sizes	Process
Daylight	Positive transparency	Agfachrome Professional	65	Sheet	Agfa 75 F
		Agfachrome CT 18	65	35 mm, roll	Agfa 68 F
		Anscochrome	32	35 mm, roll, sheet	AR-1
		Ektachrome	50	roll, sheet	E2/E3
		Ektachrome Aero Type		roll	E2/E3
		Ektachrome Infrared Aero	[1] 10	75 ft roll 9×9 in.	E2/E3
		Ektachrome Professional	50	roll	E2/E3
		Ektachrome X	64	35 mm, roll	E2/E3
		High Speed Ektachrome	160	35 mm, roll	E2/E3
		Kodachrome II	25	35 mm, roll	K-12
		Kodachrome X	64	35 mm, roll	K-12
		Super Anscochrome	100	35 mm, roll, sheet	AR-1
Daylight	Negative	Agfacolor Negative	40	35 mm, roll, sheet	Agfa N set
		Gevacolor N5	40	35 mm, roll, sheet	Gevacolor
		Ektacolor CPS	100	roll, sheet	C-22
		Kodacolor X	64	35 mm, roll	C-22
Tungsten	Positive transparency	Agfachrome CK20	65	35 mm, roll, sheet	Agfa 68 F
		Agfachrome Professional	65	sheet	Agfa 75 F
(3,200°K)		Anscochrome	25	sheet	AR-1
(3,200°K)		Ektachrome Sheet Type B	10	sheet	E-1
(3,200°K)		High Speed Ektachrome B	125	35 mm	E2/E3
(3,200°K)		Super Anscochrome	100	35 mm, roll	AR-1
(3,400°K)		Ektachrome Sheet Type B	32	sheet	E2/E3
(3,400°K)		Kodachrome II Type A	40	35 mm	K-12
(3,400°K)		Kodachrome Professional Type A	16	35 mm	K-12
(flash)		Ektachrome Roll Type F	25	35 mm, roll	E2/E3
(flash)		Kodachrome F	15	35 mm, roll	K-12
Tungsten	Negative	Agfacolor Negative	40	35 mm, roll, sheet	Agfa N set
		Gevacolor N 3	40	35 mm, roll, sheet	Gevacolor
(3,200°K)		Ektacolor L	16	sheet	C-22
(flash)		Ektacolor S	25	sheet	C-22
(flash)		Kodacolor X	45	35 mm, roll	C-22

[1] With No. 12 filter

produce finer results but require more exposure.

e. The final product is, in general, one of two types—a positive transparency or a paper print. Reversal color films are used to make transparencies, for either slides or direct viewing. You can use reversal film to produce color prints, but a better choice of film for paper prints is negative color film. There are also some special purpose films such as duplicating and aerial film.

f. Color films are divided into two categories designated by the type of light that you should use with them—daylight or tungsten. Tungsten light is classified as either flash, photoflood, or studio flood. Color film is highly sensitive to the color differences in light, so normally you shouldn't use film manufactured for one type of light with other types of light.

9-13. Different Light Source—Different Color

a. As we go about in daylight, we see color reflected by many objects. We often fail, however, to notice that the blues are bluer and the reds are darker than they would be under incandescent lights. Daylight is principally white; it contains all colors, but it has a little more blue than it has other colors. Color film sees the difference. In daylight, therefore, you should use daylight film. Also, you should use blue flashbulbs with daylight film because they produce a color similar to daylight.

b. Daylight color changes with the height of the sun. Sunlight is yellow, but the filtration and scattering action of the atmosphere cause daylight to appear blue. This blueness is most noticea-

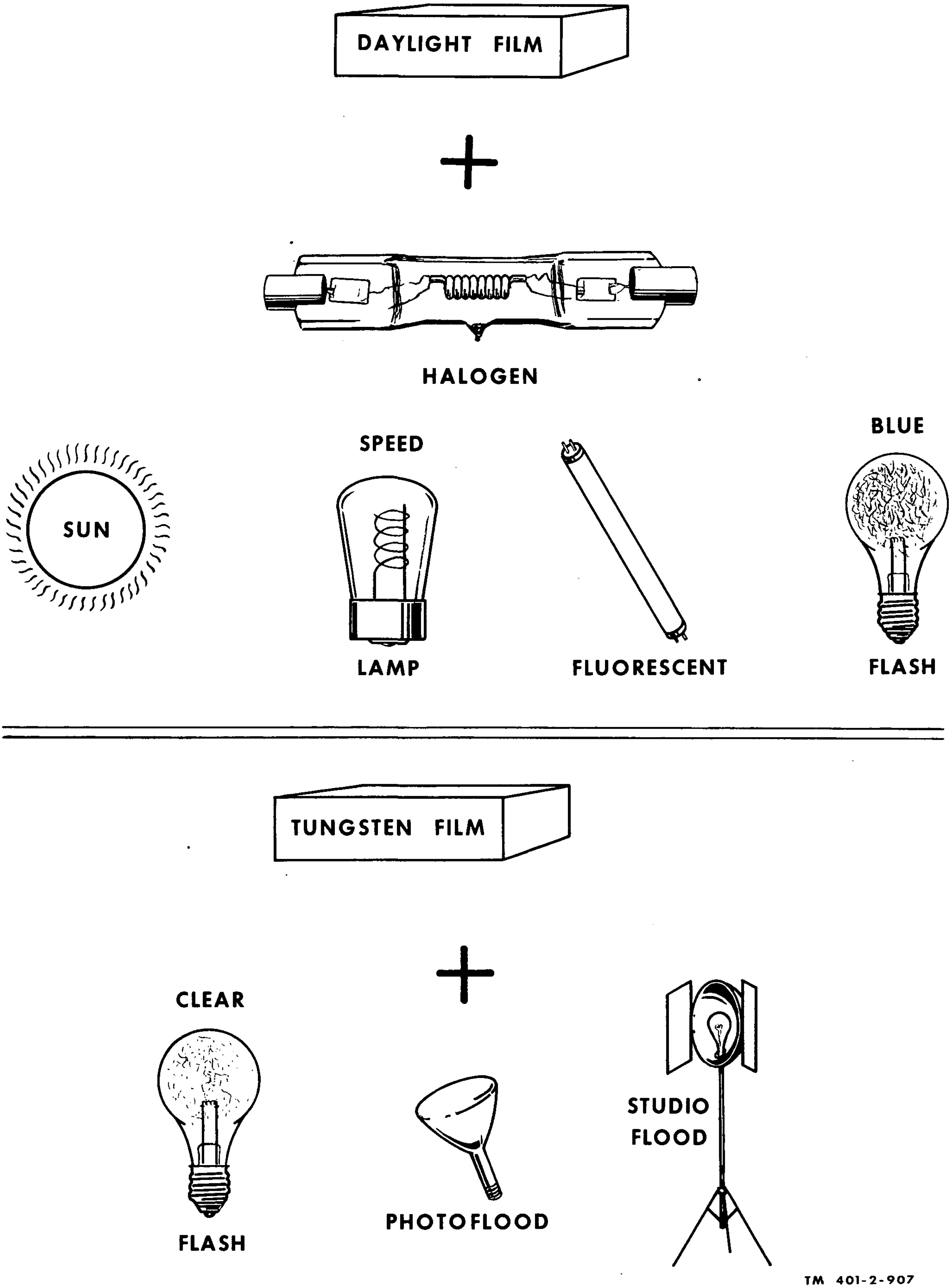

Figure 9–7. Film type and light source.

ble in shadows and on overcast days. In the early morning and late afternoon, the refraction of the atmosphere bends more of the red light from the sun toward the earth. To sum up, photographs made in the early morning and late afternoon are redder, in bright sun are more yellow, and in overcast and open shade, such as the uncovered shade of a building, are bluer.

c. Speed lamps (electronic flash), daylight fluorescents, and arc lamps are bluish. Use daylight film when photographing with these light sources (fig. 9-7).

d. Also, daylight film should be used with halogen lamps such as the quartz-iodine types that produce a constant daylight quality throughout their life. Halogen lamps have a tungsten filament inclosed in a narrow quartz (or other material) tube containing a trace of halogen gas such as iodine or bromine. The gas causes a recycling of the tungsten so that it redeposits on the filament rather than depositing on the walls of the tube. This eliminates darkening of the lamp with use. The net result is that both the color temperature and the light intensity of the lamp remain constant throughout the life of the lamp. Halogen lamps burn at higher temperatures (provide higher light efficiency) and have a longer burning life than other types of lamps.

e. Most artificial (or electric) light is reddish. Exactly how red depends on the type of lamp, the age of the lamp, and the voltage applied to the lamp. The color gets redder with age, and a 10-volt change in the applied voltage will probably produce a noticeable color change. Thus, you should use the film manufacturer's recommended light source or an appropriate filter (paras 9-16 and 9-17).

Section III. COLOR TEMPERATURE

9-14. Kelvin Temperature Describes Color

a. A heated object radiates energy. At low temperatures the radiant energy is heat. With an increase in temperature the wavelengths of the radiation become shorter. Humans, with a body temperature slightly less than 100 degrees Fahrenheit, radiate energy in the far-infrared. As the temperature of an object increases to that of a coal fire, some of the radiation is visible light. The color of that light is red. A further increase in temperature increases the amount of light, and the color changes from red to yellow to white to blue.

b. The light emitted by a hot, perfect radiator is not a single color but one main color with many other colors included; the radiator is similar in color distribution to most light sources. That's why we use a temperature scale to describe the color of light from a general light source.

c. We use the Kelvin temperature scale because the scale is absolute. That is, there are no negative values, and at a value of zero there is no heat. Each degree in the Kelvin scale is equal in size to one degree in the centrigrade (Celsius) scale but is 273 degrees colder. Kelvin temperature (K) equals centigrade temperature (C) plus 273 degrees as expressed by the following formula:

$$K = C + 273.$$

The relation of Kelvin to Fahrenheit is $K = 5/9 (F-32) + 273$ (fig. 9-8).

d. Kelvin temperature is a measure of heat, but when used to describe color it does not necessarily tell the temperature (heat) of the source. Color temperature for a particular light tells how hot a perfect radiator would have to be to produce the same type (color distribution) of light. The color temperature of a fluorescent lamp is about 5,000°K, but the lamp is cool enough to momentarily touch. For color temperature of other common and photographic light sources see figure 9-9.

9-15. A Decamired is a Color Unit

a. A more modern unit than the Kelvin degree for measuring the color of light is the *decamired.* The decamired scale has smaller numbers than the Kelvin values; its values increase as the color changes from blue to red. There is less likelihood when using a decamired measurement of confusing color with heat than if you use a Kelvin value.

b. A reddish light source such as a standard household lamp (2,800°K) has a high (36) decamired value. A bluish light source such as light from a clear blue sky (20,000°K) has a low (5) decamired value. You can determine the decamired value by dividing the Kelvin color temperature into 100,000 or by checking with figure 9-9.

c. The decamired value of a film describes the type of light source that you should use with the film. Daylight (5,400°K) is 18.5 decamireds, and clear flash and photoflood (3,800 and 3,400°K) are 26 and 29 decamireds. If you don't have the proper light for a particular film there are filters available for changing the decamired value of the light entering the camera.

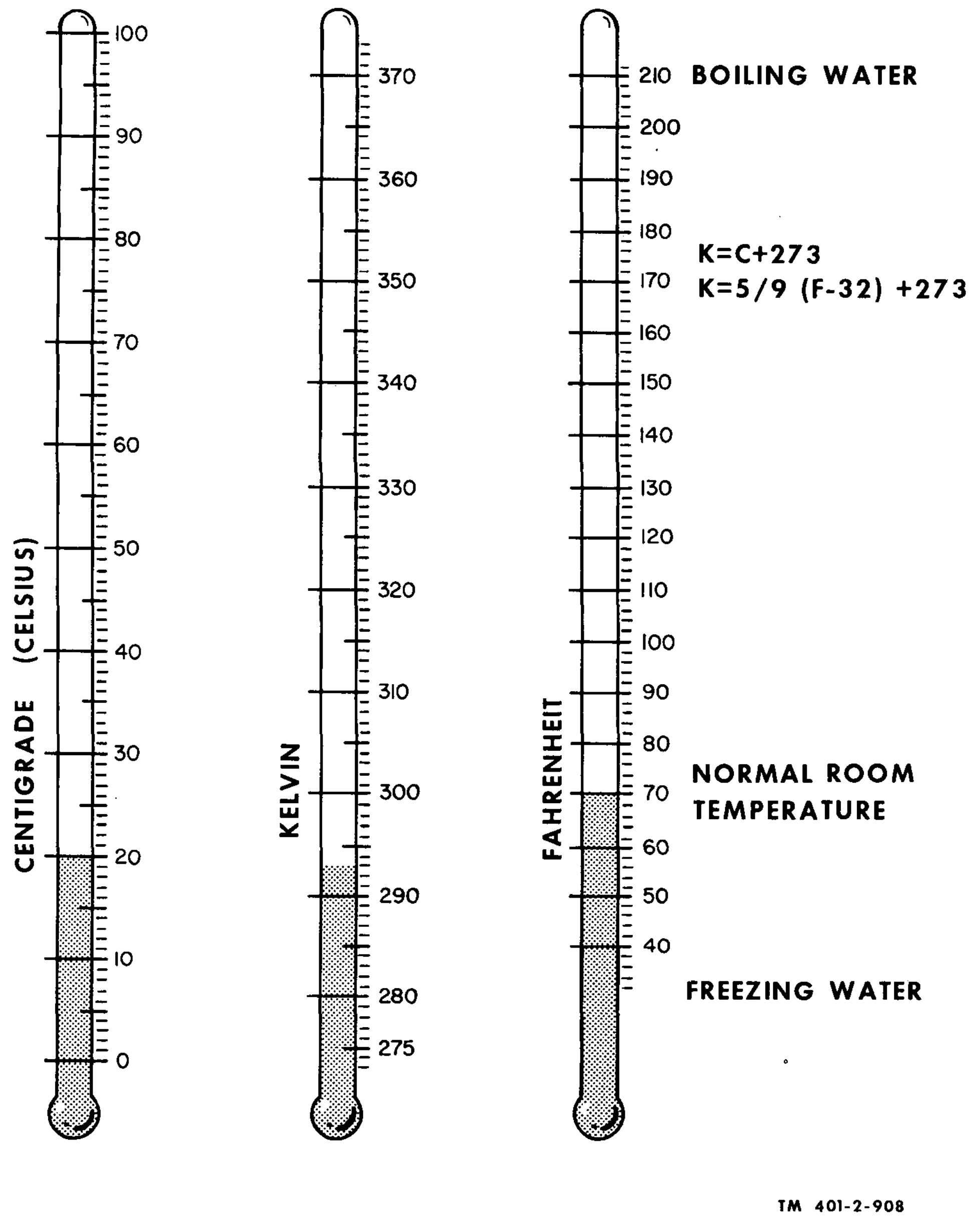

Figure 9-8. Temperature equivalents.

Section IV. FILTERS

9-16. Balancing Filter Adjusts for Color Temperature

a. When there is a color difference of more than 100°K or 1 decamired between the light source and the color sensitivity of the film, you should make some adjustment. The best adjustment would be to change the light source or change the film. But, as the best is not always practical (for instance, you cannot change natural lighting), you may have to use second best—balancing filters. A balancing filter effectively increases or decreases the color value of the light source by absorbing either some of the red or some of the blue light. Balancing filters are available in Wratten numbers that are related to Kelvin degrees. Filters are also available in decamireds.

b. To lower the color temperature, making the light less blue and more red, use either Wratten series 81 (yellow) or red decamired filters. For the effects of each filter in these series, refer to table 9-II.

COLOR TEMPERATURE SCALE

OUTDOOR	KELVIN	FILM	DECAMIRED	INDOOR
EXTREMELY BLUE CLEAR NORTH-WEST SKY	26000			
	25000		4.0	
	24000			
	23000			
	22000			
	21000			
CLEAR BLUE SKY	20000		5.0	
	19000			
	18000			
	17000		6.0	
	16000			
	15000			
	14000		7.0	
BLUE SKY WITH VERY THIN CLOUDS	13000			
			8.0	
	12000			
BLUE SKY	11000		9.0	
	10000		10.0	
	9000		11.0	
			12.0	
	8000			
			13.0	
UNIFORM OVERCAST	7000		14.0	
			15.0	
			16.0	
	6000			
			17.0	ELECTRONIC FLASH
AVERAGE NOON SUN		Daylight	18.0	DAYLIGHT FLUORESCENTS
			19.0	BLUE FLASHBULBS
	5000		20.0	
				DAYLIGHT PHOTOFLOODS
			22.0	
	4000			
			25.0	
				CLEAR FLASHBULBS
	3500			
			30.0	PHOTOFLOODS STUDIO FLOODS
		Tung-sten		
	3000			
			35.0	
				HOUSEHOLD TUNGSTEN FILAMENT LAMPS
	2500			
			40.0	
			45.0	
	2000			
			50.0	
				CANDLE FLAME

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Figure 9-9. Color temperatures.

Table 9-II. Use of Filters

Desired effect	Degree of effect	Filter	Color	Required increase of exposure in f/Stops
Lower the color temperature.	100°K	Wratten 81	Yellow	1/3
	200°K	Wratten 81A		1/3
	300°K	Wratten 81B		1/3
	400°K	Wratten 81C		1/3
	500°K	Wratten 81D		2/3
	600°K	Wratten 81E		2/3
	650°K	Wratten 81EF		2/3
	700°K	Wratten 81F		2/3
	800°K	Wratten 81G	Red	1
	3 decamireds	Decamired R3		1/3
	6 decamireds	Decamired R6		1/2
	9 decamireds	Decamired R9		5/6
	12 decamireds	Dacamired R12		1
	15 decamireds	Decamired R15		1-1/3
	18 decamireds	Decamired R18		1-1/2
Raise the color temperature.	100°K	Wratten 82	Blue	1/3
	200°K	Wratten 82A		1/3
	300°K	Wratten 82B		2/3
	400°K	Wratten 82C	Blue	2/3
	3 decamireds	Decamired B3		1/2
	6 decamireds	Decamired B6		1
	9 decamireds	Decamired B9		1-1/2
	12 decamireds	Decamired B12		2
	15 decamireds	Decamired B15		2-1/2
	18 decamireds	Decamired B18		3
Absorb blue	Peak Density	Wratten	Yellow	
	0.05	CC-05Y		
	0.10	CC-10Y		1/3
	0.20	CC-20Y		1/3
	0.30	CC-30Y		1/3
	0.40	CC-40Y		1/3
	0.50	CC-50Y		2/3
Absorb green	Peak Density	Wratten	Magenta	
	0.05	CC-05M		1/3
	0.10	CC-10M		1/3
	0.20	CC-20M		1/3
	0.30	CC-30M		2/3
	0.40	CC-40M		2/3
	0.50	CC-50M		2/3
Absorb red	Peak Density	Wratten	Cyan	
	0.05	CC-05C		1/3
	0.10	CC-10C		1/3
	0.20	CC-20C		1/3
	0.30	CC-30C		2/3
	0.40	CC-40C		2/3
	0.50	CC-50C		1
Absorb green and blue.	Peak Density	Wratten	Red	
	0.05	CC-05R		1/3
	0.10	CC-10R		1/3
	0.20	CC-20R		1/3
	0.30	CC-30R		2/3
	0.40	CC-40R		2/3
	0.50	CC-50R		1

Table 9-II. Use of Filters—Continued

Desired effect	Degree of effect	Filter	Color	Required increase of exposure in f/Stops
Absorb blue and red.	Peak Density	Wratten	Green	
	0.05	CC-05G		1/3
	0.10	CC-10G		1/3
	0.20	CC-20G		1/3
	0.30	CC-30G		2/3
	0.40	CC-40G		2/3
	0.50	CC-50G		1
Absorb green and red.	Peak Density	Wratten	Blue	
	0.05	CC-05B		1/3
	0.10	CC-10B		1/3
	0.20	CC-20B		2/3
	0.30	CC-30B		2/3
	0.40	CC-40B		1
	0.50	CC-50B		1-1/3
Subdue glare and reflections.	No effect on color balance	Pola-screen	Gray	2
Darken sky	No effect on color balance	Pola-screen	Gray	2
Subdue haze	Most daylight film. See manufacturer's film data for specific filters.	Skylight 1A or Haze UV-2A	Clear faint yellow	
Use daylight film in tungsten light.	Most daylight film gives poor results in tungsten light even with filters.	Wratten 80 series. See manufacturer's film data for specific filters.		
Use tungsten film in daylight.	Most tungsten film can be used in daylight with the proper filter.	Wratten 85 series. See manufacturer's film data for specific filters.		

c. The following is an example of how to lower the color temperature. Assume you are using photoflood lamps (3,400°K, 29 decamireds) with type B (3,200°K, 31 decamireds) film. There is a difference of 200°K or 2 decamireds. A filter *will* not change the film: it alters the light. So, according to table 9-II, you must select a filter that will raise the decamired value (lower the color temperature) 3 decamireds, one more than is desired. If you were using decamired filters you'd have to decide whether 1 decamired too red is better than 2 decamireds too blue. Although you can calculate exact values mathematically to the nth degree, personal tastes and sensitivities to color differences, which play a large role in photography, allow a good bit of freedom in your choice.

d. To raise the color temperature, use either a Wratten series 82 (blue) filter or a blue decamired filter.

e. Remember that light balancing filters effectively alter the color of the light source, not the film sensitivity. Also note that the effects of the filters are additive. That is, you may use one filter on top of another and simply add the effects of each to get the total effect. Although the effects are additive, it is better it use a single filter that will give the same total effect.

9-17. Conversion Filters Change Daylight to Photoflood

a. You can correct the large color imbalance caused by using daylight film with floodlamps or tungsten film in daylight by using conversion filters rather than balancing filters. The color difference between daylight and tungsten light is about 2,800°K. Filter types that are generally used are given in *b* and *c* below; however, it is always best to *check the manufacturer's data* packaged with the film.

b. To use tungsten film in daylight, select one of the Wratten 85 series filters (fig. 9-10). Use a Wratten 85 filter for film normally used with photofloods (3,400°K), a Wratten 85B filter for film normally used with 3,200°K floods, and a Wratten 85C filter for film normally used with clear flashbulbs.

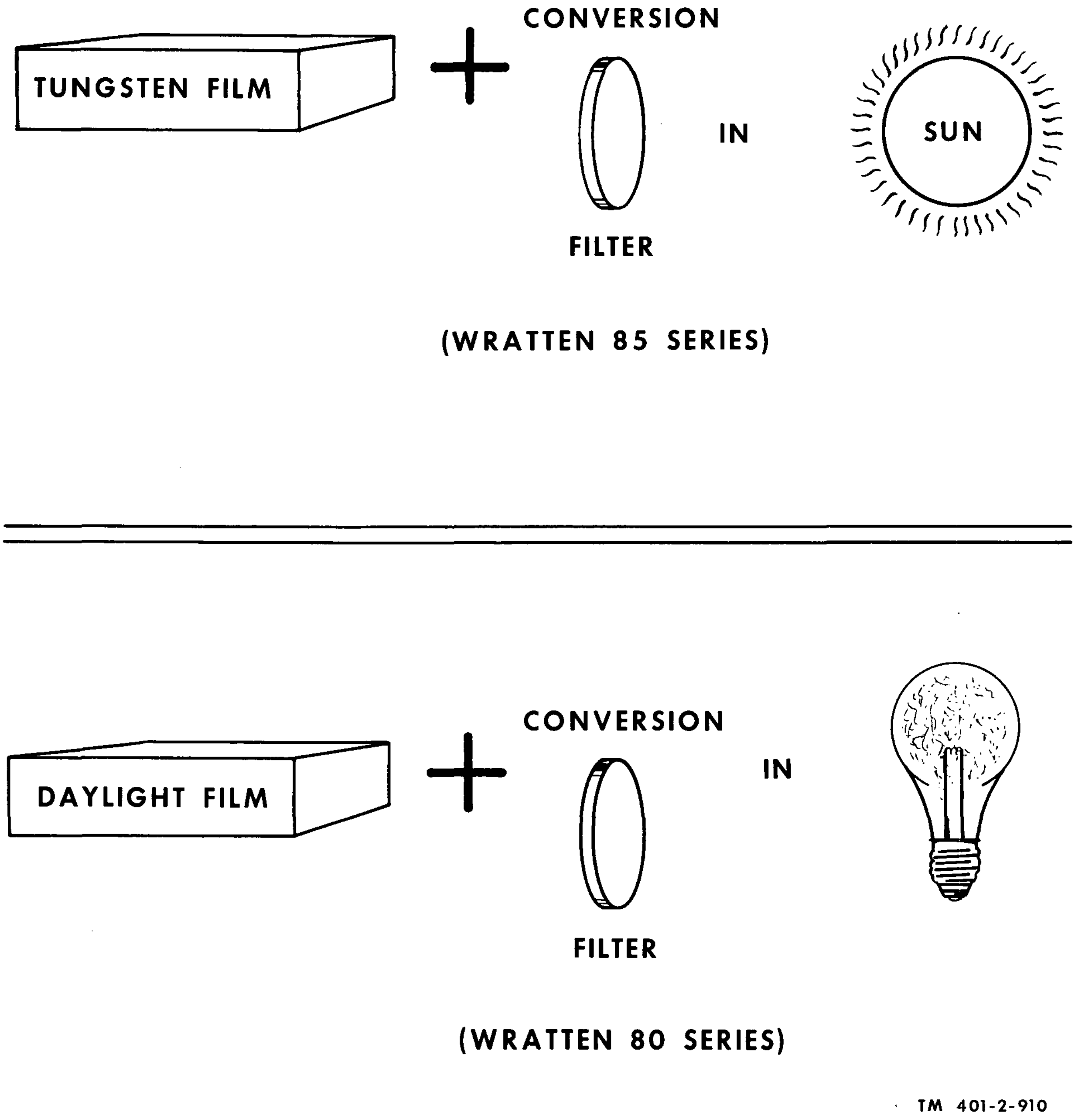


Figure 9-10. Use a conversion filter.

c. We strongly recommend that you *do not* use daylight film with tungsten light. The results are usually inferior, even with the appropriate Wratten series 80 filter. The Wratten 80B filter is generally used to photograph with daylight film and studio flood or photoflood lamps, while a Wratten 80C filter is preferred with daylight film and clear flashbulbs. In all cases it would be better to omit the filter and use either electronic flash or blue flashbulbs because they both produce a light similar to daylight.

9-18. Filters Reduce Haze

a. The more shade or overcast and the greater the distance you photograph, the more haze will appear in your picture unless you use a filter to reduce the haze effect on the film.

b. A common filter used to reduce haze in open shade or light haze is the Wratten Skylight 1A filter. An overcast or a distant landscape may require a stronger haze filter such as Haze No. 1 or a UV-2A filter.

9-19. CC Filters Make Color Corrections

a. Color correction (CC) filters absorb various amounts of specific colors. They can make one color darker while apparently saturating its complement. Remember that color film used with the proper light source and balancing or conversion filter has a response similar to the eye. CC filters may be used to make corrections for improper film and/or illumination color balance.

b. Use CC filters principally in the laboratory to make color corrections when copying or printing. *For example,* when a negative is excessively red, you could use a cyan CC filter to reduce the effect of the red and thereby strengthen the other colors. CC filters are also used in the studio to compensate for slight variations between batches of color materials. *For example,* if a negative is too red, a red CC filter is required, and if a positive transparency is too red, a cyan CC filter is necessary.

c. Color correction filters are available in various densities for all primary and secondary colors. The number of the filter describes the filter's effects. Take, for instance, the Wratten CC–05Y filter. The CC stands for color correction. The 05 is the density, which indicates the amount of absorption. The larger the numbers the more the filter absorbs. The final letter, Y in this case, is the color of the filter. The Wratten CC–05Y is a yellow filter; it absorbs blue, thus reducing the blue color and strengthening yellow. See table 9–II for effects of other CC filters.

9–20. Polarization Filters Do Not Affect Color

a. Polarization filters are gray, so they have the same effect on all colors. They are used in color photography to subdue glare and reflection just as in black and white photography.

b. An important function of polarization filters is to darken blue skies for more dramatic color photography results or for emphasis of autumn leaves against the sky.

c. All filters stop some of the light from reaching the film. So in most cases where you use filters you will have to increase the exposure. The necesary increase in exposure for specific filters is given in table 9–II.

Section V. EXPOSURE

9–21. How to Determine Exposure

a. The process of determining exposure is the same for color and black and white except for the rule: *light the shadows*. Color film has a narrow exposure latitude and requires flat frontal lighting or a low (3:1 or less) lighting ratio. Because it's easier to increase the light level in the dark areas than decrease the brightness of the light areas, we assume in determining exposure that the highlights are of normal brightness. As a result, we expose for the highlighted areas and add light to the shadows to decrease the lighting ratio.

b. In black and white photography a difference in brightness of highlights and shadows is necessary for form and texture. In color photography the form, texture, and contrast is determined more by the colors than by the relative brightnesses. Also, under weak illumination (or underexposure) colors are darkened, and in intense illumination (or overexposure) colors are lightened. Thus, although the process of determining exposure is the same for both film types, you should be most careful in determining exposure for color film.

9–22. Use Gray Card for Exposure

a. The narrow exposure latitude of color film (in general $\pm\frac{1}{2}$ stop) requires a more even illumination and a more carefully determined exposure than black and white film. Use a neutral gray card and an exposure meter whenever possible. Some exposure corrections are possible in the laboratory; however, properly exposed film produces the best results.

b. It's desirable to include a neutral gray card and a standard color scale in the picture, positioned so they can be easily deleted from the final print. If the film is to be used directly for positive transparencies, then you should make an extra exposure and include the gray card and the color scale on this one. This will help the lab man, who probably doesn't know the actual color of the subjects, to determine the trueness of the color and possibly correct any deficiencies.

Section VI. SUMMARY AND QUESTIONS

9–23. Summary

a. The rules of composition for black and white photography are applicable to color.

b. Keep your color schemes simple and employ only one or two saturated colors.

c. Use complementary colors for contrast and saturated colors for center of interest.

d. Reflections from bright, colored objects near the subject may alter the apparent color of the subject.

e. Framing is more critical in color photography than in black and white.

f. One type of additive film is a panchromatic emulsion covered with a combination filter consisting of many tiny red, green, and blue filters side by side.

g. Subtractive color film has three separate layers of color-sensitive emulsions: one sensitive to blue, one sensitive to green, and one sensitive to red. In color developer the blue-sensitive layer turns yellow, the green-sensitive turns magenta, and the red-sensitive turns cyan.

h. You select color film according to the size of your camera, the final product, the processing, the film speed, and the light source.

i. Daylight is bluish. In daylight use daylight film or tungsten film and a conversion filter.

j. Sunlight is more yellow than the average daylight while shadows and overcast are very blue.

k. Daylight color varies with the height of the sun—when the sun is low, the light looks reddish; when the sun is high, the light looks bluish.

l. Speedlamps, daylight fluorescents, and arc lamps are bluish.

m. Tungsten light is reddish, and a 10-volt change in applied voltage produces a noticeable color change. Use the recommended light-film combination, and a balancing filter or a conversion filter.

n. Color temperature is expressed in Kelvin degrees and describes the color distribution of light.

o. A decamired is a unit for measuring the color distribution of light. It is equal to 100,000 times the reciprocal of the Kelvin color temperature.

p. Balancing filters adjust the light to the color sensitivity of the film. Yellow Wratten 81 series and red decamired filters lower the color temperature. Wratten 82 series and blue decamired filters raise the color temperature.

q. Use Wratten 85 series filters to adjust daylight for tungsten film.

r. Haze is a veil of blue that is most noticeable in distance, shade, overcast, and backlighted landscape. Haze filters, such as the skylight 1A, reduce the effect of haze.

s. Color correction (CC) filters are used principally in the laboratory to make color corrections by absorbing a specific amount of one color. They may be used during exposure for special effects or to correct for improper color balance in the light source or the film.

t. Polarization filters have no effect on color. They can be used in color photography because they are in black and white.

u. Color film requires a low lighting ratio, preferably flat frontal lighting, and a carefully determined exposure.

v. With color film you expose for highlights and light the shadows.

9–24. Review Questions

a. What is the color of a normally blue object if it is illuminated by red light?

b. What two primary colors of light are added to produce:
(1) Yellow?
(2) Cyan?
(3) Magenta?

c. What is the difference between a saturated and unsaturated color?

d. What are the complementary colors of—
(1) Blue?
(2) Green?
(3) Red?

e. Most color film has three light-sensitive emulsions. What colors are they sensitive to and what is the developed color of each?

f. Available processing is one factor that determines what type of color film you should use; what are the other four factors?

g. Name the three general classifications of tungsten photographic light and their approximate color temperatures.

h. What is the rule for the exposure of color film?

i. What type of filter is used to obtain true color rendition with tungsten film in daylight or daylight film in tungsten light?

j. Use table 9–II to select a Wratten and a decamired filter that will change the light of a 3,200°K flood to 3,800°K.

9–25. Answers to Review Questions

a. Black.

b. (1) Green and red.
(2) Green and blue.
(3) Red and blue.

c. Unsaturated colors contain gray, and saturated colors do not.

d. (1) Yellow.
(2) Magenta.
(3) Cyan.

e. The blue-sensitive emulsion develops yellow; the green-sensitive emulsion develops magenta; and the red-sensitive emulsion develops cyan.

f. Camera size, light source, film speed, and final desired product.

g. Clear flashbulb, 3,800°K; photoflood, 3,400°K; and studio, 3,200°K.

h. Expose for highlights and light the shadows.

i. Conversion filter. Wratten 85-series converts daylight to tungsten light.

j. Wratten 82C and decamired B6.

CHAPTER 10

DIFFUSION TRANSFER PHOTOGRAPHY

10-1. Introduction

How would you like to take instantaneous available light photographs by moonlight, capturing exactly what you wish and doing little more than clicking the shutter? Well, films with this fantastic capability are not yet available. In the future, however, you may well be able to take that very picture in the moonlight, using a film with an ASA equivalent rating of 10,000 or more. And what's more, you will be able to take two, three, or more of these pictures in less than 1 minute—exposed, developed, and printed! What kind of process could make this all possible—the diffusion transfer (Polaroid) process.

10-2. Uses of the Polaroid

a. The Polaroid camera set in figure 10-1 is self-contained, portable, and hand-operated. The camera component is used to make still photographs using a $3\frac{1}{4}$- by $4\frac{1}{4}$-inch Polaroid film pack.

b. You can use a Polaroid camera set in situations when speed and the certainty of immediate results are important. With it, you can make and process on-the-spot photographs in either black and white or in color. And it can be used even under extreme lighting conditions. Some of the jobs that you may be able to use a Polaroid camera for are—

(1) Battle area surveillance (night and day).

(2) Quick prints in aerial spotting.

TM 401-2-1001

Figure 10-1. A Polaroid camera.

(3) Combat and tactical photography.

(4) Test prints.

(5) Scientific and technical photography.

c. Some of the advantages of a Polaroid camera over other cameras are—

(1) It reduces the amount of equipment necessary in a forward area laboratory.

(2) It is so simple to operate that high technical skill is not needed.

(3) There is the increase of effective film speed from 400 to 10,000. ASA 3,000 is now standard for Polaroid although slower speeds are still needed and used.

(4) The film used provides an increase in the effective film speed from 400 (maximum for conventional film) to 10,000. ASA 3,000 is now standard for Polaroid although slower speeds are still required and used.

10-3. The Polaroid Process

a. When you think of all the lab equipment and steps that the Polaroid process eliminates, you can readily see what a unique process it really is. Besides loading the camera, opening the case, and extending the front assembly, there is little more for you to do. To take a picture, find the subject in the finder assembly and make the exposure. After the exposure you pull the paper tab. This removes a sandwich of film, paper, and chemical from the camera (A, fig. 10-2).

10-4. A Lot Happens When You Pull

a. When the film is advanced, the exposed negative and the positive paper strips are forced together between two steel rollers (B, fig. 10-2).

b. At the beginning of the positive paper is a foil pod of chemical. Because the pod is too big to fit between the rollers the pod is squeezed open, spreading a very thin (about .0003 inch) layer of the jellylike liquid evenly between the negative and positive materials (C, fig. 10-2).

c. This develops the *exposed* silver halide in the emulsion of the negative much the same as in conventional wet processes.

d. The *unexposed* silver halide is converted to soluble complexes, but is not fixed out as in a conventional hypo bath.

e. Instead, the *soluble silver diffuses* across the microscopically thin layer of the processing re-

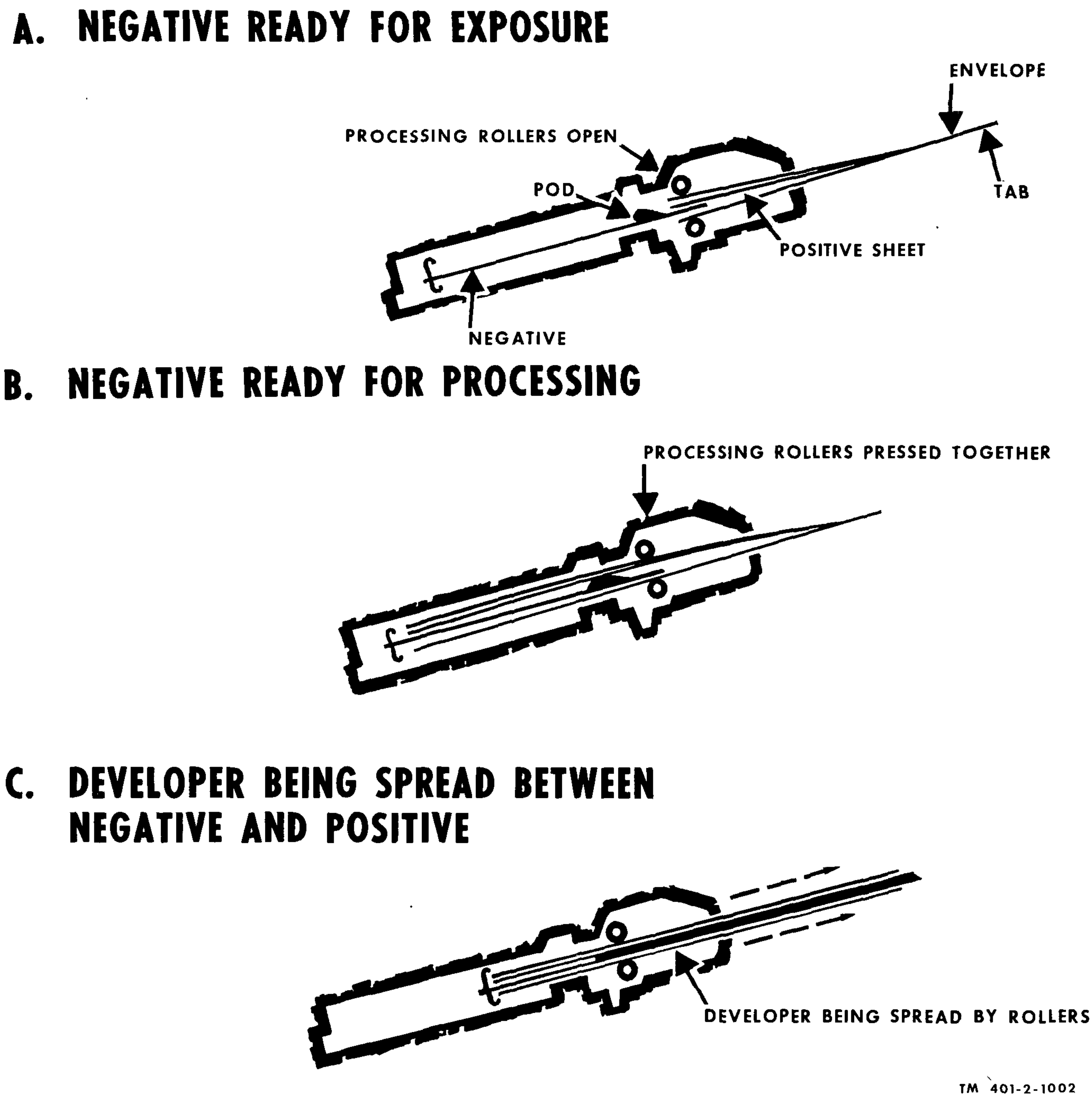


Figure 10–2. Initiating development.

agent and is transferred to the positive sheet. On the positive sheet the silver is caused to precipitate as metallic silver to form the positive image.

f. Both of these reactions take place almost simultaneously. The positive image is forming while the development of the negative is taking place.

g. This process of image formation is called the *diffusion transfer reversal method.* It's not a new method, but Polaroid is the first to use it successfully. Prior to the Polaroid development, the process had many faults. One fault was that it could only be used on extremely slow papers. Another fault was that the image was brown even though there was extremely high contrast.

10–5. Polaroid Transparencies

a. Polaroid film has *high resolution.* A Polaroid 3¼- by 4-inch transparency gives as much detail as a 9- by 8-inch Polaroid print.

b. So the Polaroid transparency has a tremendous advantage over prints for intelligence. Why? Because it has high resolution and also because Polaroid transparencies can be *projected.*

Table 10-I. Characteristics of Polaroid Film

Description	Film No.	ASA		Devel. time (sec.)	Print size and No. per roll	Positive transparency size and No. per roll
		Daylight	Tungsten			
4 x 5 Film Packets	52	200	160	10	4 x 5	
	53	200	160	60	4 x 5	
	57	3,000	2,400	10	4 x 5	
	55 P/N	100	80	20	4 x 5	
Infrared	#25 filter	560		10	3¼ x 4¼, eight	
	#87 filter	200		10	3¼ x 4¼, eight	
Polaroid Land Picture Rolls black and white.	32	400		10	2¼ x 3¼, eight	
	37	3,200		10	2¼ x 3¼, eight	
Polacolor	38	80		50	2¼ x 3¼, six	
Polaroid Land Picture Rolls black and white.	42	200		10	3¼ x 4¼, eight	
	44	400		10	3¼ x 4¼, eight	
	46	1,000	750	120		2¼ x 2¼, eight
	46L	1,000	750	120		3¼ x 4, eight
	47	3,200		10	3¾ x 2¾, eight	
Polacolor	48	80		50	3¼ x 4¼, six	
Projection film for lantern slides	146L	120		10		3¼ x 4
Polascope	410	10,000		10	3¼ x 4½, eight	
Black and white in plastic pack	107	3,000		10	3¼ x 4¼, eight	
Polacolor in plastic packs	108	75		50	3¼ x 4¼, eight	

c. Another advantage is the fast emulsion. Polaroid films are available in emulsion speeds up to 3,000 ASA and on an experimental basis up to 10,000 ASA.

d. Table 10-I describes general characteristics of Polaroid film, and table 10-II gives special uses and instructions for the film.

10-6. Developing the Polaroid Film

a. Polaroid film starts developing when you pull the tab. If you are using Polaroid Land Film Holder #500, it starts when you remove the packet. When you use the film with tabs, always pull the tab straight out, swiftly, firmly, and without hesitation.

b. You can control the contrast to a very slight degree by varying the amount of time you allow the picture to develop. Increasing the developing time increases contrast; decreasing the time lowers contrast.

c. Cold weather slows down the developing action of all films and you should follow the manufacturer's instructions. In extreme cold weather, carry the camera inside your jacket so that your body heat will keep the pods of reagent from freezing.

d. Polacolor film must be developed when the temperature of the film is between 60 and 90 degrees F. Underdeveloping increases contrast slightly with a definite color shift toward blue.

10-7. Black and White Prints Require Special Coating

a. Polaroid black and white prints require a coating immediately after developing. This preserves the delicate highlight renderings and prevents changes in tone. A coating applicator is provided in each box of film. Once you have coated the prints they are extremely durable.

b. When you coat the print, make sure you do it on a flat, clean surface, such as a film box. Otherwise, small particles may be picked up by the coating applicator and scratch the print. Use several firm, straight, overlapping strokes so that

Table 10-II. Polaroid Film Uses and Instructions

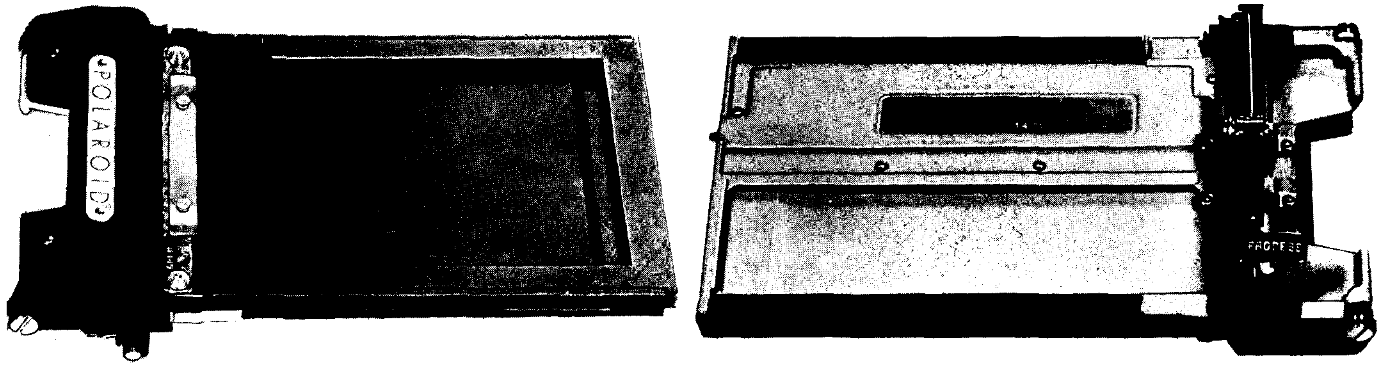
Description	Film No.	Processing instructions	Spectral sensitivity	Cameras available for—	Recommended uses
4 x 5 Film Packets	52		Pan	Polaroid Land 4 x 5.	General.
	53	Must be washed and fixed in darkroom.	Pan	Film Holder	General.
	57		Pan	Film Holder	Action available light.
	55 P/N	3 min. in 18% sodium sulphite solution—5 min. wash.	Pan	Film Holder	Big enlargements from negatives.
Infrared	#25 filter #87 filter		Extends to 910 millimicrons.	All using 40 series film.	Laser, medical, aerial, crime, etc.
Polaroid Land Picture Rolls black and white.	32		Pan	Series 80, J33	Action available light.
	37		Pan	Series 80, J33	Action available light.
Polacolor	38		Color film	Series 80, 80A, and 80B.	Full color prints.
Polaroid Land Picture Rolls black and white.	42		Pan	Series 95, 100, 700, 110, 150, 160, 800, 850.	General.
	44		Pan		General.
	46	20 sec. in dippit type 644.	Pan		Med. contrast slides.
	46L	20 sec. in dippit type 646.	Pan		Med. contrast slides.
	47		Pan		Action available light.
Polacolor	48		Color film	All 3¼ x 4¼ Sets.	Full color prints.
Projection film for lantern slides	146L		Pan	All 3¼ x 4¼ cameras except J66.	High contrast lantern slides.
Polascope	410		Pan	All 3¼ x 4¼ cameras.	Oscilloscope photography.
Black and white in plastic packs	107		Pan	Automatic 100	General action.
Polacolor in plastic packs	108		Color film	Automatic 100	Full color prints.

you'll completely cover the surface of the print. If the humidity is low, the prints will dry in a few minutes. In humid weather, the prints may take 10 or 15 minutes to dry.

10-8. Special Electronic Shutters Available on the Model 100

a. A unique feature of the newer Polaroid model 100 is that it has an automatic electronic shutter. With other cameras using built-in meters, the photocell determines the amount of light available for exposure and sets the exposure before the shutter release is depressed. The Polaroid shutter, however, has a cadmium sulfide photocell. It begins reading exposure when the shutter is opened, and automatically closes the shutter when enough light has reached the film.

b. The unique feature of this shutter is that it works with photoflash lamps, reading the light and responding by closing the shutter in milli-



FRONT BACK

Figure 10-3. Polaroid film holder #500.

seconds. At the other extreme, the shutter gives prolonged exposure in conditions of low light intensity. When you shoot in such conditions, hold the camera steady until you hear a final click indicating that the shutter has closed.

10-9. Your KE-12 Can Be Polaroid

a. The Polaroid 4 by 5 Land Film Holder (fig. 10-3) is designed to fit your KE-12 Graflex. It will allow you to make 4- by 5-inch pictures on film contained in individual packets. Each packet contains negative and positive film materials and a developing pod in a lighttight envelope with a metal cap at one end.

b. Here are the three steps involved in photographing with the KE-12 modified for Polaroid:

(1) Insert the packet into the holder and lock the cap. Take out the envelope (fig. 10-2) to allow the negative to be exposed.

(2) After the exposure, slide the envelope back into the holder and again lock the metal cap. Then move the processing lever on the holder to the PROCESS position. This action closes the stainless steel pressure rollers on either side of the envelope.

(3) Then withdraw the entire packet through the rollers (fig. 10-4). This causes the pod to break and begin development.

c. The major advantage of this process over the roll film process is that you don't need to wait between exposures while the film is developing. You can remove the packet from the holder while it is processing, or you can take it out undeveloped and process it later at your convenience.

10-10. Roll Film Also Available for KE-12

Roll film can also be used with a special back for the KE-12. When you use roll film, one problem you must consider is that the special back displaces the film plane and, in effect, the focal length of the camera is changed. To correct this displacement, use a special adapter plate to measure lens-to-film distance. The adapter plate adjusts the lens so that the vernier scale can be used even though the lens is not pulled out to the infinity stops.

10-11. Use Conventional Exposure Methods With Land Cameras

The information in table 10-III will permit you to use a conventional exposure meter with Land cameras calibrated in shutter settings. When depth of field or stopping action presents a special problem, table 10-III is especially helpful in determining the shutter speed and aperture resulting from the Land camera settings.

Table 10-III. Conventional Equivalents of Land Camera Shutter Numbers

Shutter setting	Lens opening	Shutter speed (sec.)	Shutter setting	Lens opening	Shutter speed (sec.)
1	f/8.8	1/12	5	f/12.5	1/100
2	f/8.8	1/25	6	f/17.5	1/100
3	f/8.8	1/50	7	f/25	1/100
4	f/8.8	1/100	8	f/35	1/100

10-12. Print Defects

Table 10-IV shows a number of common faults of Polaroid prints and their probable causes. You can use it to help correct any defects that might show up on your prints.

10-13. Questions on Polaroid Photography

a. Name seven photographic situations where it would be advantageous for you to use Polaroid.

b. After you pull the paper tab, what mechan-

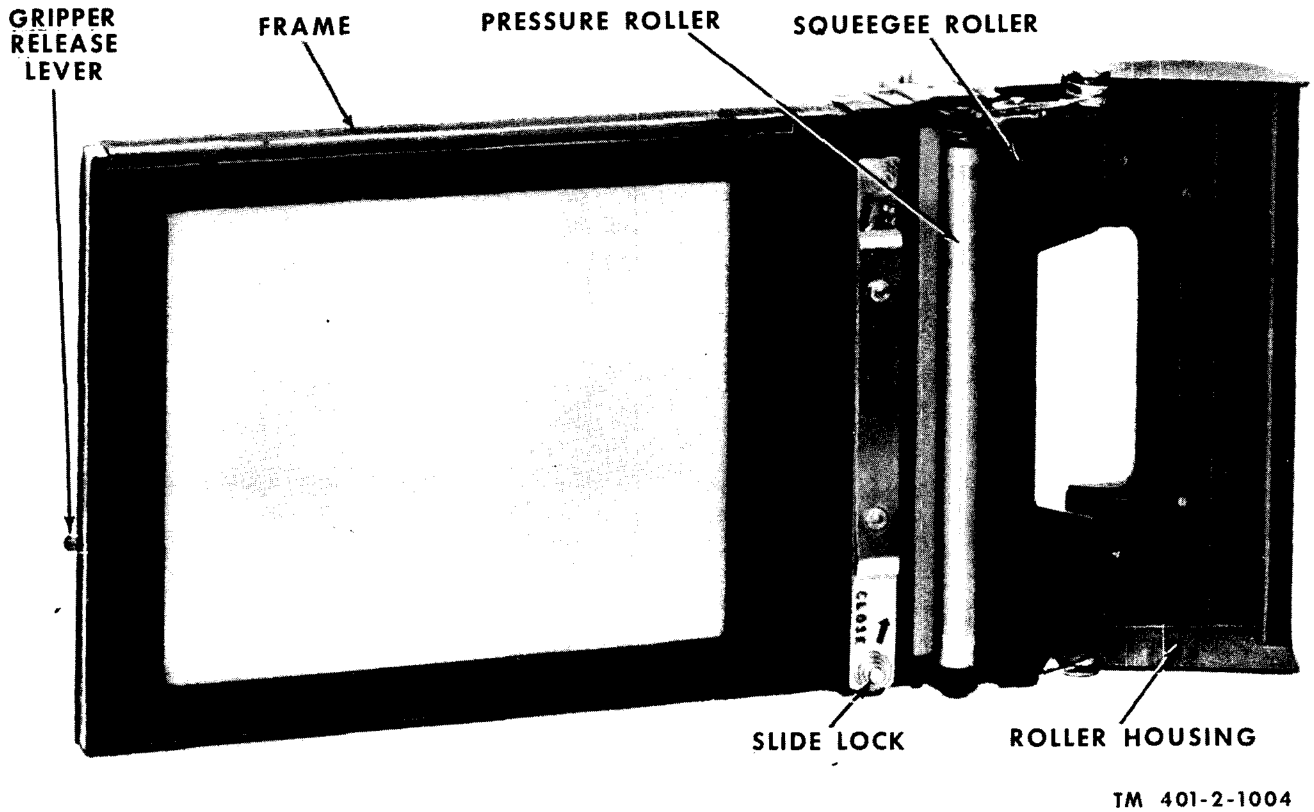


Figure 10-4. Film holder opened.

isms actually initiate the development of the picture?

c. The __________ __________ __________ is converted to soluble complexes but is not fixed out as in a conventional hypo bath.

d. Briefly explain what the term *diffusion transfer reversal* means.

e. What characteristic makes a Polaroid transparency useful for intelligence purposes?

f. In coating a developed print, what precautions should you take?

g. If you discover that your print has a black area at the end of the print, what is your problem? (Use table 10-IV.)

Table 10-IV. Black and White Print Defects and Causes

Print defects	Causes
Total blank—black	No exposure reached film. Check all operations. Be sure shutter is cocked and tab is pulled.
Total blank—white	Massive overexposure to light; could be badly damaged or old developer pod.
Print too light	Overexposed.
Print too dark	Underexposed.
Black area at end of print.	Tab pulled only part way.
Streaks across print	Hesitant tab pulling.
Developer smear	Some developer sticks to print instead of negative. May be due to hesitancy in removing print or severe over- or underdevelopment. To remove

Table 10–IV. Black and Wite Print Defects and Causes—Cont.

Print defects	Causes
Developer smear—Cont.	spots, scrub them firmly with coater.
Partial development	Usually due to damaged developer pod or using old, outdated film.
White spots repeated regularly acrcss film.	Dirt or dried developer reagent on steel rollers. Keep rollers clean.
Flat, muddy prints	Underdevelopment.
Fading highlights	Improper coating, failure to coat, or bad storage conditions.
Streaky fading	Print not fully and evenly coated.
Edges fogged	Light has leaked in at edges of negative roll.
Brown stains	Developing reagent left on face of print. Always coat prints immediately.

10–14. Answers to Questions

a. Some uses of the Polaroid are—

(1) Battle area surveillance.

(2) Quick prints.

(3) Test prints.

(4) Limited laboratory facilities required.

(5) Increased effective film speed.

(6) Simplicity of operation.

(7) Simplification of forward area photography.

b. Two steel rollers.

c. The *unexposed silver halide* is converted to soluble complexes but is not fixed out as in a conventional hypo bath.

d. The soluble silver halide *diffuses* across the microscopically thin layer of the reagent and is *transferred* to the positive plate. The silver precipitates as a black metallic substance, thus *reversing* the image.

e. High resolution.

f. Be sure to completely cover the print with coating. Coat print as soon as possible. Wait until coat is dry before handling.

g. The tab has been pulled only part way.

CHAPTER 11

MILITARY NEWS AND INFORMATION PHOTOGRAPHY

Section I. NEWS PHOTOGRAPHY

11-1. Introduction

As a still photographer, you have many functions that cover many fields of photography. You may be shooting portraits on one assignment and making aerial surveillance flights on the next. You will probably find that a majority of your assignments will involve news and information photography.

11-2. What is News?

a. The dictionary will give you a formal definition of news, but as a practical matter if you seek to photograph subjects that will *interest* and/or *inform* people, more often than not you will record news.

b. That sounds simple enough, but to be sure you have the real thing, here are some qualities of news.

(1) *Immediacy* (timeliness). This is why news is NEW(s). People are interested in current events.

(2) *Proximity* (close to home). You are more likely to be interested in news happening within your own company than in a company in Germany.

(3) *Consequence.* News that affects many people rather than a few select persons.

(4) *Prominence.* Relates to the greatness of the subject.

(5) *Oddity.* An unusual event that is inherently newsworthy.

(6) *Conflict.* Depicts man pitted against man, man versus nature and the elements, and the like.

(7) *Human interest.* In most cases, this means sports or finance for men and social events or fashions for women.

(8) *Emotion.* Examples are curiosity, sympathy, and anger.

(9) *Progress.* This is good news that shows a change for the better.

c. You may find that any one or all of these qualities exist in a news topic. Often you will have to develop these qualities in your photographs so that your pictures will be newsworthy.

11-3. What is a News Photographer?

a. The way you photograph the news may well determine how easily and correctly the reader interprets the message. Photography has been called the universal language because it is easy to read, but to make a photograph that effectively communicates takes a skill that is not easily learned.

b. We assume you have technical competence. This plus the following characteristics make you a news photographer.

(1) You must give less attention to operating your camera and more to seeing and interpreting the subject.

(2) You must have a nose for news.

(3) You must be aggressive, yet able to get along with people.

(4) You must use *originality.*

11-4. Use Originality

a. No one photographer is a carbon copy of another. However, among professionals there are certain similarities. One, originality, is using imagination and being able to visualize a potential picture.

b. Train yourself to see pictures in your daily life. Study scenes you encounter: people's faces, children's expressions and attitudes, contrast of skies and clouds, or a thousand other things you see evey day.

c. An unusual approach often pays off. A subject that looks dull and uninteresting in the daytime sometimes becomes a prize-winning picture when shot at dusk, at night under street lights, or in the rain or snow.

d. Patience is an important quality that you must develop. Often you must wait until the exact instant that is right to get the best picture.

e. Routine assignments that you have to go on time after time usually become dull and unexciting. You can bring them to life and make them interesting if you use your imagination and originality.

f. Cropping to bring out unusual effects in an original manner can many times make a picture outstanding.

g. Avoid dull record photos that answer only the question of *who* is in the picture, *what* they are doing, *when* they are doing it, *where*, and *how*. The big WHY this is happening and the meaning behind it all is too often not apparent in the picture. Stating, visually, *why* something is happening will transform an ordinary record picture into a picture of startling importance and interest.

h. Original thinking will lead you to think in terms of breaking down the action. Long shots, medium shots, and closeups add sidelights of human interest.

i. In evaluating a picture intended for news release, you should ask yourself the following questions:

(1) Does the picture say what it is intended to say?

(2) How well does it say it?

(3) Will what it says interest the viewer?

11-5. News is for Information, Promotion, and Records

a. Although news coverage is not a prime mission of the Army, the Army does support a large number of newspapers and magazines and supplies information to the general public via commercial periodicals. In this manner, the Army keeps military personnel and civilians abreast of military events and affairs.

b. Besides informing the military and the public, the Army also uses news coverage to improve its prestige and to promote interest in the Army.

c. As today's news is tomorrow's history, many news articles become historical records.

d. In summary we can say that the Army uses news coverage to inform, to promote, and to record. Remember that pictures tell stories and are an important part of news coverage.

11-6. Three Types of News Coverage

We divide news coverage into three types—spot news, general news, and feature news.

a. Spot news is generally a onetime occurrence, unannounced and spectacular. This is the front page type of news. As a spot news photographer you need to be quick with your camera and have a nose for news. You must sense the breaking of a newsworthy event, be on the scene, be in position, and quickly photograph the story, often amid confusion and fast-moving action.

b. General news such as a sports event or a ceremony is news that you know beforehand will happen. You know what, where, and who of the event, and have some idea of the type of photographs needed, but you decide the exact pictures to take during the event. You should roughly preplan the coverage of general news.

c. Feature news describes the activities of some person, organization, or group. You plan coverage in detail before photographing. You know the whole story beforehand, and your job is to write the story with pictures.

11-7. Types of Picture Stories

Often, especially in writing feature news articles, a good photographer will use the picture story, which differs substantially from usual news reports because the picture story has many pictures. There are three types of picture stories—illustration-for-text, picture-text combination, and the all-picture story. You'll see short examples of each in figure 11-1.

a. Illustration-for-text uses photographs to illustrate the main points and dress up the article. The pictures supplement the written story, and although the story is complete in itself, the pictures must be meaningful and not simply decoration. In illustration-for-text articles the text usually takes more space than pictures.

b. Picture-text combination uses words and photographs combined to tell the story. If either is omitted, the story is not fully told. The pictures should be related to each other so that the reader can get the idea being presented by looking at the pictures. In picture-text combination articles the space is more or less equally divided between words and pictures.

c. An all-picture story tells a story completely with pictures. Words are kept to a minimum. The story is usually a simple one. A single idea, thought, or concept is presented with pictures that are closely sequenced. The reader must be able to look from one photograph to the next, right on through the series, and see the story develop smoothly.

11-8. What Makes a Good News Photograph?

Since you are a professional photographer, all of your pictures should be technically perfect. In addition, news photographs must have storytelling ability, aptness, dignity, accuracy, and visual value.

a. The story that a single picture tells should not be complex or complicated. One photograph rarely tells the complete story, but each picture must convey a clear idea or thought.

b. A news photograph must have aptness; that is, it must be well suited for the story, the reader, and the publication.

c. Your pictures should be dignified. Never needlessly degrade or humiliate any person or

ILLUSTRATION FOR TEXT

WRITING A PICTURE STORY

There is more to writing a picture story than just photographing. You must research the subject, develop a theme, write an outline, check the sequence of the outline, and write a script before you do any photographing. Your story should convey a message, so you must plan each picture to thoroughly express your ideas.

After you've photographed and printed the pictures, arrange them in a clear, storytelling layout.

PICTURE-TEXT COMBINATION

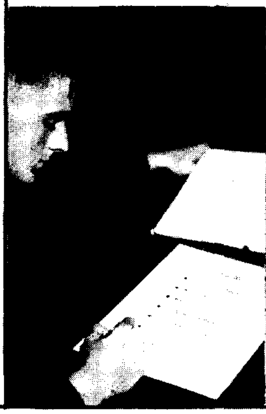
WRITING A PICTURE STORY

There are seven steps to writing a picture story:

1. Research the subject.

2. Develop a theme.

3. Write



4. Check the sequence of the outline.

5. Write a script that describes each picture.

6. Photograph the scenes in the script.

7. Layout.

ALL-PICTURE STORY

WRITING A PICTURE STORY

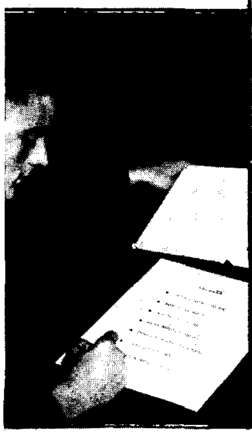


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Figure 11–1. Picture stories.

organization in your photographs. People in your photographs should be appropriately dressed, performing suitable actions, and placed in their proper relationships.

(1) There are two very good reasons for maintaining dignity in your photographs. First of all, it's the nice way to be. And second, you could be sued for libel if your photographs are degrading.

(2) Lack of dignity can occur in a tightly planned feature article because many of the pictures are posed. Because a pose is not the real thing, the resulting photograph may give false representation. Try to have your subject act naturally, and when possible photograph reality rather than posed scenes.

d. News pictures must be accurate and truthful. You can use special lighting, filters, odd angles, and other tricks of photography to strengthen your point, but be careful not to create a false impression.

e. Your photographs must have good visual value. They must possess qualities that will attract and make the viewer pause to look at the picture. The photographs in figure 11-2 have qualities that attract the viewer's attention. Following are some of the qualities that increase a picture's visual value.

(1) *Good composition.* Obviously, the picture should be properly composed to attract the viewer. Chaper 2 discusses how you obtain good composition in a photograph.

(2) *Human interest.* People are interested in other people. Usually, men favor sports, conflicts, and pretty girls, while women are more interested in children, social events, and fashion. Our interest in an event is even greater when the event is unusual, near to home, and recent.

(3) *Action.* You hold the viewer's attention when the picture shows something actually happening. Preferably, you should catch the event at its high point.

(4) *Impact.* A photograph should grasp and hold the viewer's attention and interest. Some subjects by nature have inherent impact. Other pictures gain impact by compositional arrangement.

(5) *Unposed appearance.* The photograph should have a natural, unposed quality that makes the scene look alive.

(6) *No dead space.* Get closeups. Let the scene you want fill the negative.

(7) *Emotional expression.* An excellent way to show a mood, a feeling, and many indescribable concepts is by facial expression.

(8) *Varied camera angle.* Things that are different or unusual are attention getters.

(9) *Dramatic lighting.* Use proper lighting to obtain a predetermined, desired effect.

(10) *Security compliance.* Although in-

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Figure 11-2. Photographs with good visual value.

cluding classified information in your photographs will increase its value in certain circles, its value to the Army as a news picture is zero. The picture will be destroyed, and you'll get into serious trouble.

11–9. How to Plan a Photo Story

a. Before you take any pictures, *plan your photographic story* with as much detail as possible. You cannot plan for spot news because it happens suddenly without warning, but you can and should plan your coverage of general news such as sports events and VIP visits (paras. 11–13 through 11–18) because they are usually prescheduled. You should thoroughly plan feature articles.

b. Your assignment starts with a subject, a topic, or an event. The first thing to do is to *research the subject.* Identify the subject; find out what it does and how it operates. Find out the reason for its existence; learn its background and history. Determine what effects the subject has on people, organizations, communities, and nations. If possible, determine its probable future.

c. From your research and knowledge *develop a theme* for your story. Write down the principal concepts or ideas that you will illustrate with pictures.

d. Write an outline for the story by listing each of the thoughts, actions, or points that you want to include in the story. Check the sequence of the outline. There should be a definite order that allows you to move smoothly from one point to the next without any gaps. Present actions in the order that they normally occur, especially if one action leads to another.

e. Write a script and describe each scene that you want to photograph starting with the key picture, which is the one photograph that best brings out the theme of the story. The description should include photographic techniques you will use. Next describe the introduction picture. This photograph should be a strong attention getter. Add descriptions of pictures that will bring out each item in the outline. Then select a closing scene. A boat sailing off into the setting sun may seem corny, but it's the type of picture that obviously says, "This is the end." With a more controversial topic you may want to leave the story open-ended to promote further discussion, but you'll still need a closing scene, one that gives your last word on the subject. Add descriptions of supplementary photographs: pictures to use in place of others, pictures to aid and support the presentation given by photographs already described, and pictures to fill in any gaps or rough spots in the story.

f. Go over your script and check the sequence and the presentation. Add any techniques you may have omitted—lighting, camera angle, time, exposure, and so forth.

11–10. How to Photograph a Story

With your script prepared and all the necessary equipment and material assembled, you're ready to photograph the story.

a. Get to the scene early.

b. Use your script, and when possible follow the sequence of the story when photographing.

c. Be prepared for the unexpected because it may make the best photograph.

d. Make duplicate photographs—no exact copies but photographs of the same scene with slight variations.

e. Take extra pictures as the situation arises. Some of your exposures probably will not appear in the final story; however, it's better to have extra pictures than to be without one you wish you had taken.

f. Write a caption for each exposure and be specific, complete, and use layman's language. Include background, side interests, and the full and proper names of people, outstanding equipment, buildings, and the location. Do not abbreviate. And number each caption so that relating script, exposures, and captions is an easy task.

11–11. Summary of News Photography

a. The Army photographs news events to keep personnel informed, promote interest, and keep records.

b. Photographic new coverage is categorized as spot, general, feature, illustration-for-text, picture-text combination, and all-picture story.

c. News photographs should have storytelling ability, visual value, aptness, dignity, and accuracy.

d. You increase the picture's visual value by good composition and by including human interest, action, unposed appearance, closeups, emotional expression, variety, and dramatic lighting.

e. An ideal news photographer has a nose for news, quick picture sense, quick reflexes, wide knowledge, planning ability, and social assurance.

f. Plan your coverage before photographing.

g. Photograph your picture story according to your plan, but when fitting take extra photographs for possible changes in the story or for improving the coverage.

11-12. Questions on News Photography

The answers are in paragraph 11-33.

a. What is the difference between illustration-for-text and picture-text combination stories?

b. List the following picture story writing tasks in the order that you should perform them.

Do the photographing.
Develop a theme.
Do the research.
Get a topic.
Prepare an outline.
List the principal concepts.
Write the script.

c. List the following pictures in the order that their description should be written when you are writing the script to a picture story:

Introductory.
Picture for item three in the outline.
Picture for item two in the outline.
Key.
Supplementary.
Closing.

d. Which of the following are true when you photograph a picture story?

(1) Get to the scene ahead of time.
(2) Photograph the script exactly.
(3) Do not take extra pictures.
(4) Captions are not necessary.

Section II. VIP PHOTOGRAPHY

11-13. Introduction

Army photographers, especially those engaged in information photography, often spend much time photographing high ranking military and civilian personnel. Any visit, inspection, or tour made by very important persons (VIPs) to an Army installation is of interest to the news media. Photographs of these events are made for release to local, post, and hometown newspapers. They can also be used for record purposes.

11-14. Qualifications of the VIP Photographer

a. To be a good VIP photographer you must be technically qualified. You must be so thoroughly familiar with your equipment that its operation is second nature. You can quickly make adjustments to satisfy the rapidly changing conditions.

b. You must keep a cool head and think quickly because in this type of photography you will be working under pressure. In one instant, you may be photographing a group of seven or eight people from 20 feet, and, split seconds later, may be in for closeups at 6 or 8 feet. Advancing film, adjusting lens aperture, changing focus, adjusting parallax, and allowing your strobe light a few seconds for recycling—all must be done in the seconds while you are jockeying into your new position.

c. On the one hand, you must be aggressive because it is your job to bring back pictures instead of excuses. On the other hand, you must temper your aggressiveness with diplomacy and tact to secure the full cooperation of your high ranking subjects.

d. You must not be overawed by the rank of the people with whom you are working. You must, of course, observe the conventions of military courtesy; yet despite the difference in rank you must take full command of the situation and be unafraid to issue polite directions and instructions. Usually you will find that high ranking personnel are anxious to exhibit a favorable appearance and are willing to help the cameraman take good pictures.

11-15. Technical Considerations of Your Assignment

Let's assume you are going to be doing VIP coverage. Before talking about specific problems related to this type of photography, let's consider some methods to rapidly operate your equipment to permit the shortest possible delay between exposures.

a. Zone focus whenever possible. Focus as accurately as you can. But often you will find there isn't time to use the rangefinder. In this situation you should be prepared to set the lens (aperture and focus) to cover the entire depth of the zone in which the subject is likely to be. As long as the subject remains inside this zone you don't need to focus, and your attention is free to concentrate on making exposures. Of course, you must prepare in advance by deciding the different distances at which you are likely to be working, and then establishing zones of near and far distances by consulting a depth of field table for the lens you are using. This table will give you the focus distance and aperture that will provide the required depth. *For example,* if you are using a 5-inch focal length lens and know that you will be using f/8 or smaller opening, you might establish three zones:

Focused at 6 feet, your zone is 5 ft. 6 in. to 6 ft. 8 in.

Focused at 10 feet, your zone is 8 ft. 8 in. to 11 ft. 9 in.

Focused at 15 feet, your zone is 12 ft. 3 in. to 19 ft. 6 in.

At the end of this chapter you'll find two depth of field tables, one for 5-inch and one for 10-inch lenses. In your work you'll probably use the table for 5-inch lenses more often than the one for 10-inch lenses.

b. Predetermine your exposures by choosing a particular shutter speed in advance. You can determine the flash guide number and work out your f/stops beforehand. You may want to tape a distance-f/stop chart to the back of your camera. Let's assume that with the film you're using you decide to shoot at 1/200 second and find that the guide number is 160. In this case your chart might look like this:—

6 feet = f/22–32
8 feet = f/20
10 feet = f/16
12 feet = f/11–16
15 feet = f/11
20 feet = f/8
40 feet = f/4

c. Use electronic flash instead of photoflash lamps.

d. Use film pack instead of cut film. If possible, have a second film pack adaptor preloaded for quick interchange.

11–16. Before the Tour

a. Your job begins before the arrival of the VIPs. Always be prepared by thoroughly checking the camera and flash equipment. Clean all flash connections and check the batteries. It's wise also to carry an extra set of batteries in your camera case. Take along plenty of film and bulbs if you're using them. You can always bring back excess supplies, but not taking enough is likely to cause you embarrassment as well as causing you to fail to fulfill your mission.

b. Be certain arrangements are made for your own transportation to and from the tour site. Find out the tour itinerary and the route. If time permits you should go over the tour route in advance to determine the best likely camera sites.

c. Find out names of the VIPs and background information for caption writing and to permit you to direct the subjects by name.

11–17. The Tour

You'll usually cover a VIP tour in the following sequence:

a. Initial Greeting. Make this first shot upon the arrival of the VIPs. Arrival will usually be at a predetermined place so you should be ready to get the first salute or handshake. If the VIPs arrive in a car you can expect the highest ranking person to be seated on the right. You can sometimes get a good shot of the VIPs in the car, but once the door opens, save your film until they are outside. Pictures of persons exiting from an automobile usually reveal them in awkward positions.

b. Route of the Tour. You make most of your shots during this phase. Try to determine the tour highlights in order to secure coverage of the important activities. Your shooting will be governed by the purpose for which you are making the pictures. You might need only one good picture for a single news release or you might need total coverage. If you are in doubt, it is usually better to make too many photographs rather than not enough.

c. Completion of the Tour. Make your final shots upon the departure of the VIPs. Since this will involve another salute or handshake, you will have to use your imagination to make this picture differ from the initial greeting. You could, for instance, have them shaking hands at the rear of the car, rather than the front.

11–18. Photo Techniques to use During the VIP Assignment

a. If possible, make your pictures while the subjects are doing something. There should be some definite action, and the attention of all people in the picture should be directed to the point of action. Never allow the subjects to stare into the camera. If the VIPs are looking at a display, try to include the display in the picture so that the subjects are not looking outside the picture area in the final photograph. By the same token, if the action revolves around some object being handled by the VIPs, be sure their hands or bodies do not hide the object.

b. If you miss a shot or your subjects are out of position try to reposition and direct them. Often a simple "Please take a step to the right, General Brown," will be enough to get the subjects into a favorable position.

c. Even when you set up or pose a picture try to make it appear spontaneous. Don't stop the action but rather have the subjects go through an entire sequence of events.

d. Don't feel that you must include the entire entourage in all your pictures. In fact, results are nearly always better if you keep the number of people in a picture down to two or three. You must know who are the important people on the tour.

e. Anticipate action. Try to predict what will happen next and keep an eye open for your next camera position. Without getting in the way of the VIPs, position yourself ahead of the group rather than following from behind.

f. Watch the background to make sure it is related to the action taking place but not distracting.

g. If the subjects are of unequal heights, try to keep the shorter subjects closer to the camera to minimize the difference.

h. Position the flashgun so it throws the light into the group. Be careful that the flash shadow cast from a person close to the camera does not fall on another person farther away.

11-19. Awards and Presentations

There are several military ceremonies that fit into standard photographic patterns. These ceremonies are medal awards, trophies and certificates, promotions, and swearing-in. The stock methods of covering these events differ so we'll discuss how to handle each.

11-20. Medal Awards

a. In any medal presentation there are three elements involved: the recipient, the medal, and the person making the presentation.

b. The medal is pinned onto the left pocket, and you should photograph from the side. If necessary to shoot from an angle, favor the recipient by moving to the side that will show the back or profile of the person making the presentation.

c. If you take the picture during the actual pinning of the medal, it is likely to be hidden by the presenter's hands. If possible, pose this shot after the actual ceremony so you can position the subjects and can have the person pinning the medal lower his hand to give a clear view.

11-21. Trophies and Certificates

a. You usually photograph sports trophies, certificates of achievement, best mess awards, and so on, with the person making the presentation and the recipient both holding the award with their left hands and shaking right hands below it. Be sure the certificate is held upright.

b. Position the subjects as closely together as possible because a normal stance usually shows too much dead space.

c. Be careful of the background. It should be as plain as possible and contain no distracting elements.

d. Have the subjects direct their attention to either the award or to each other. Be sure they're not staring into the camera.

11-22. Promotions

When you are posing subjects for a promotion shot, have the person being promoted standing at attention. Have a senior NCO or officer holding up a new pair of stripes or pinning on a new set of bars. Observe the same precautions about posing and backgrounds mentioned above.

11-23. Swearing-In Ceremonies

When you photograph a reenlistment, show an officer administering the oath while both he and the reenlistee stand at attention with their right hands raised. If you take this picture in the reenlistment office, find a flag or other suitable object to use for a background and to help fill in the dead space.

11-24. Now, Here are Some Helpful Hints

a. What we described above are called stock poses. They are the ways such pictures are nearly always made. The stock picture of two people holding a certificate, shaking hands, and saying "cheese" to the camera has come to be referred to as the "grip and grin" picture.

b. But you don't have to make yours the same, and in fact, you will probably get tired of turning out a flood of stereotyped pictures. To gain more self-satisfaction and to elevate the status of Army photography, you should try to make photographs containing real interest and individuality. It's up to you to use your imagination in each case. For instance —

(1) If a person receives an award for an act connected with his job, picture him at his job rather than in someone's office holding a certificate.

(2) If a soldier has just reenlisted, show him enjoying the benefits instead of standing at attention with his hand in the air.

(3) For a best mess award, have the mess sergeant proudly showing the kitchen to his commanding officer, or show him preparing an attractive display of food.

(4) Picture a man who just graduated from a service school performing his new duties instead of staring at his diploma.

11-25. Summary of VIP Photography

a. A good VIP photographer must be technically qualified, coolheaded, and aggressive.

b. Utilize the principle of zone focus.

c. Remember that your job begins before the tour—be prepared.

d. A tour will usually consist of three principal points: the initial greeting, the tour, and the completion of the tour.

e. Use good photo techniques: make your pictures while the subject is doing something, don't arrest action but repeat a sequence, anticipate the action, and watch the background.

f. Remember that you can make even the most routine missions challenging and interesting for you and your readers.

11–26. Review Questions on the VIP Tour

The answers are in paragraph 11–34.

a. Let's assume that you will be using a camera with a 10-inch focal length lens at f/11. Using table 11–II, make a zone focus chart for three zones of focus where you anticipate most of the action will happen.

Focused at 8 feet, your zone is .... to ....

Focused at 10 feet, your zone is .... to ....

Focused at 30 feet, your zone is .... to ....

(If you have your own camera available, try making a zone focus chart for it.)

b. Along with the zone focus chart, what other aid will shorten your preparation time for a flash exposure?

c. In the event that you miss a key shot and the entourage is moving on, what might your action be?

d. Name the three important factors in the presentation of a medal.

Section III. WRITING CAPTIONS

11–27. Introduction

A very important part of your job will be preparing complete and accurate captions for all pictures. Remember, negatives without captions will be destroyed, regardless of their quality. Before discussing the actual writing of the captions let's discuss how to use DA Form 3315 (Photographer's Caption).

11–28. How to Use the Form

Although DA Form 3315 (fig. 11–3) looks pretty simple you will have to keep in mind that after the film is developed you may never see the job again. The picture you have taken and the caption data will be used together and *must* tell the whole story. Let's see what's required on the form.

a. Date and time. This is the date and time the picture was taken and not necessarily the date that you may have filled out the form.

b. Photographer's name.

c. Photo unit. Give your unit.

d. Purpose for coverage. State why the picture was taken.

e. Film type.

f. Project or job number. Generally, the person who assigned the job to you will have a job number assigned.

g. Complete. Check whether the assignment is complete or not.

h. Location of photo coverage. Where you took the picture. In garrison this might be a room or building number; in the field you might need to designate a unit or grid coordinates.

j. Subject. Just that! What's in the picture. The subject might be very clear to you, but someone else might not have the slightest idea what your picture is all about.

PHOTOGRAPHER'S CAPTION (AR 108-5)	DATE AND TIME
PHOTOGRAPHER'S NAME	PHOTO UNIT
PURPOSE FOR COVERAGE	FILM TYPE
PROJECT OR JOB NUMBER	COMPLETE ☐ YES ☐ NO
LOCATION OF PHOTO COVERAGE	
SUBJECT	

ROLL / PACK	FEET / FRAME	SCENE	DESCRIPTION OF EVENT

DA FORM 1 MAR 68 3315 REPLACES DA FORM 11-178, 1 FEB 64, WHICH IS OBSOLETE; AND DA FORM 11-191, 1 DEC 47, WHICH WILL BE USED.

* U.S. GOVERNMENT PRINTING OFFICE : 1968 O—299-114

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Figure 11–3. DA Form 3315 (Photographer's Caption).

j. Roll/pack, feet/frame, scene.

k. Description of event. This should be a concise and complete explanation of the photograph. See paragraphs 11-29 and 11-30 on how to complete this portion of the form.

11-29. Captioning Your Photographs

a. As we have already told you, your photographic coverage will be of no value unless the pictures are identified by correct captions. Remember that captioning *completes* the story of the picture by answering these questions:

(1) *Who* is it?
(2) *What* is it?
(3) *Where* is it?
(4) *How* did it happen?
(5) *Why* did it happen?
(6) *When* did it take place?

b. You use DA Form 3315 (fig. 11-3) for recording this information.

c. Fill out an individual caption for each exposure. You might want to write a *master caption* to relate important information common to a series of pictures, but this doesn't relieve you from the responsibility of preparing a caption for each exposure.

d. The processing lab will prepare the *final caption* from information submitted by you on the DA Form 3315. This caption will appear on the back of each print distributed and on the jacket of each record negative.

11-30. Final Captions Identify the Picture

a. The final caption for a photograph identifies the picture by stating facts in concise sentences about the subject.

b. Someone in the processing lab will be writing the caption so be sure your information is complete. You should try to include most of the following important information in each caption—

(1) The assigned picture number.

(2) The geographical location where the picture was taken.

(3) The date and time of exposure.

(4) The unit being photographed and the parent organization to which the unit is attached or assigned.

(5) The name and model of equipment, major components, and other material in the picture.

(6) The full name, rank, and title or position of identifiable persons. Individuals in group pictures should be identified from left to right. Pictures for *Information Hometown* release should state the individual's hometown.

(7) The name of the operation, exercise, or activity taking place. Describe the action, situation, conditions, and methods employed. Give the numbers, sizes, shapes, and distances involved.

(8) The site where the subject is located. Name the place by building, street, city, town, or state. If in open country name the terrain feature, the distance, and the direction from the nearest identifiable place. For field operations use map coordinates and be sure to give the basic map sheet identification number.

(9) Your rank, full name, and the unit to which you are assigned.

11-31. Operational or Intelligence Captioning

In addition to the information above that you'll always be required to give, you must also give the following information when you caption operational or intelligence photography:

a. The time of the exposure and the zone letter indicator.

b. Camera location to include grid coordinates, map identification, and height above mean sea level or the hill number as given on your map.

c. Magnetic compass bearing of photographic target.

11-32. Questions on Captioning

Answers to these questions are in paragraph 11-35.

a. What are the six questions that you must answer in your caption?

b. What is the difference between a final caption and a master caption?

c. Briefly state five items of information that you should include in a caption.

d. Name three items of additional information required in an operational or intelligence caption.

11-33. Answers to Questions On News Photography in Paragraph 11-12

a. An illustration-for-text story uses photographs to illustrate the main points and dress up the article. Picture-text combination uses words and pictures combined to tell the story.

b. (1) Get a topic.
(2) Do the research.
(3) Develop a theme.
(4) List the principal concepts.
(5) Prepare an outline.
(6) Write the script.
(7) Do the photographing.

c. (1) Key.
(2) Introductory.
(3) Picture for item two in the outline.
(4) Picture for item three in the outline.

(5) Closing.
(6) Supplementary.

d. The first is true.

11–34. Answers to Questions in Paragraph 11–26

a. 7 ft. 8 in. to 8 ft. 6 in.
9 ft. 4 in. to 11 ft.
24 ft. to 39 ft.

b. Use a predetermined exposure chart. (See guide number data supplied with the lamps and also chapter 8.)

c. You can merely say, "General Scot, would you please move back here, sir?"

d. (1) The recipient.
(2) The medal.
(3) The presenter.

11–35. Answers to Questions in Paragraph 11–32

a. Who, what, where, how, when, and why.

b. A *master caption* relates information common to a series of pictures, and a *final caption* is written by the lab from information submitted by the photographer.

c. (1) Geographical location.
(2) Unit being photographed.
(3) Who took the pictures.
(4) The name of the operation, exercise, or activity taking place.
(5) Who is in the picture.

d. (1) The time of the exposure.
(2) Camera location.
(3) Magnetic compass bearing of the photographic target.

Table 11–I. Depth of Field for 5-Inch Lens

Focus point	F/4.7		F/5.6		F/8		F/11		F/16		F/22	
Feet	Near	Far	Near	Far	Near	Far	Near	Far	Near	Far	Near	Far
6	5′ 9″	6′ 4″	5′ 8″	6′ 5″	5′ 6″	6′ 8″	5′ 4″	7′ 10″	5′	7′	4′ 1″	8′
8	7′ 6″	8′ 6″	7′ 4″	8′ 9″	7′ 2″	9′ 1″	6′ 10″	9′ 7″	6′ 5″	10′ 6″	5′ 11″	12′ 3″
10	9′ 3″	10′ 11″	9′	11′ 2″	8′ 8″	11′ 9″	8′ 3″	12′ 8″	7′ 8″	14′ 4″	7′	17′ 8″
15	13′ 4″	17′ 2″	12′ 11″	17′ 10″	12′ 3″	19′ 6″	11′ 5″	22′	10′ 4″	27′ 6″	9′ 1″	43′
30	25′	40′	22′ 8″	44′	20′ 6″	56′	18′ 4″	83′	15′ 9″	330′	13′	Inf.
50	35′	88′	32′	108′	28′	217′	24′ 3″	Inf.	19′ 10″	Inf.	15′ 9″	Inf.
100	54′	Inf.	48′	Inf.	39′	Inf.	32′	Inf.	25′	Inf.	18′ 8″	Inf.
∞ Hyper-focal distance	116′	Inf.	93′	Inf.	65′	Inf.	47′	Inf.	33′	Inf.	23′	Inf.

Table 11–II. Depth of Field for 10-Inch Lens

Focus point	F/4.7		F/5.6		F/8		F/11		F/16		F/22	
Feet	Near	Far	Near	Far	Near	Far	Near	Far	Near	Far	Near	Far
6	5′ 11″	6′ 1″	5′ 11″	6′ 2″	5′ 9″	6′ 4″	5′ 9″	6′ 4″	5′ 8″	6′ 6″	5′ 6″	6′ 9″
8	7′ 10″	8′ 2″	7′ 9″	8′ 3″	7′ 9″	8′ 4″	7′ 8″	8′ 6″	7′ 4″	8′ 9″	7′ 3″	9′ 2″
10	9′ 8″	10′ 4″	9′ 6″	10′ 7″	9′ 4″	10′ 8″	9′ 4″	11′	9′	11′ 4″	8′ 8″	12′
15	14′ 4″	15′ 9″	14′ 2″	15′ 10″	13′ 8″	16′ 8″	13′ 6″	17′	13′	18′	12′	20′
30	27′ 5″	33′ 3″	26′ 10″	34′	25′ 6″	36′	24′	39′	22′ 6″	45′	20′ 6″	55′
50	43′	60′	41′	62′	39′	69′	36′	81′	32′	113′	28′	214′
100	76′	147′	72′	163′	64′	Inf.	57′	Inf.	47′	Inf.	39′	Inf.
∞ Hyper-focal distance	318′	Inf.	257′	Inf.	179′	Inf.	130′	Inf.	90′	Inf.	65′	Inf.

CHAPTER 12

INTRODUCTION TO AERIAL PHOTOGRAPHY

12–1. General

This chapter is a general introduction to aerial photography, including the responsibilities for and purposes of aerial photography. It will introduce to you the general procedures necessary for carrying out an aerial photographic mission. Chapters 13 through 18 explain aerial photography in detail, discussing types of pictures, what equipment to use, flight plans and maps for the aerial mission, and what to do during the actual mission.

12–2. Responsibilities for Aerial Photography

a. The Air Force and the Army share the responsibilities for aerial photography. The Air Force performs general, high altitude, and large area aerial photography. That includes the mapping of large areas and any deep penetration of enemy territory. The Air Force is also responsible for the orientation and interpretation of air photographs.

b. The Army performs local area photographing, any supplementary aerial photography required, and accomplishes any urgent requirements. In addition, the Army is responsible for processing and disseminating Air Force photographic information.

12–3. Purposes of Army Aerial Photography

Army aerial photography accomplishes two broad purposes—local area mapping, and surveillance and reconnaissance.

a. The Army performs local area mapping. This provides information used to select attack routes; orient patrols; select bivouac, command post, and radio relay sites; lay out wire or cable communication lines; and update and correct existing maps.

b. The Army also performs aerial surveillance of enemy territory to observe enemy defenses, troop concentration and movement, attack routes, ford and bridge sites, supply routes, artillery and other targets, and troop strength and weapons. The information obtained by aerial surveillance is used to orient patrols, detect camouflage, and assess the effects of artillery fire.

c. Aerial surveillance also includes taking aerial photographs of friendly territory. This provides information used to evaluate camouflaging techniques; select sites for artillery, outposts, command posts, etc.; and to plan road, bridge, and other construction.

12–4. Types of Aerial Photographs

Aerial photographs must be sharp, have great detail, and be properly composed so that they satisfy the needs of the requester. They must be worth the effort and danger involved in taking them.

a. Types of aerial photographs are designated by their composition. A pinpoint aerial photograph contains a target small enough to be included in one exposure. Two pictures photographed so that they may give a three-dimensional effect are called a stereo aerial photograph. Long narrow targets are photographed by making a series of overlapping exposures called a strip. When several strips are pieced together to form one composite picture of a large area, it is called a mosaic.

b. Aerial photographs are also designated by the angle of the camera used for taking the picture. Vertical aerial photographs are made with the camera looking straight down from the aircraft. Oblique photographs are made with the camera looking out and down from the aircraft from anywhere bewteen 0 and 90 degrees. Horizontal aerial photographs are made with the camera looking straight out the window of a low flying aircraft.

12–5. Equipment for Aerial Photography

The choice of camera, film, and other equipment for an aerial mission depends on the target and the type of photograph to be made.

a. A manual camera system has the advantage of being completely controllable by the photographer throughout the mission. This means you can make last minute changes if necessary after the target is reached.

b. An automatic camera system can be used in pilotless aircraft and is operated by electronic control units. The advantage of an automatic camera is its accuracy of exposure intervals and overlap for strips and mosaics.

c. A semiautomatic camera system combines the advantages of both manual and automatic systems. With a semiautomatic camera, the photographer operates some controls and has some flexibility. The precision achieved with an automatic system is still retained.

d. Any type of film can be used for aerial photographs depending, of course, on the type of camera. There are special kinds of aerofilm that should be used for specific missions. There are enough types and sizes of aerial film available to fit almost any need, so your selection should be based on the purposes of the mission and of the final pictures.

e. The use of other equipment, such as flares, lenses, and filters, depends on the mission and the selected camera.

12-6. Planning an Aerial Mission

To get the most out of an aerial photographic mission, you must carefully plan each phase of the operation. After you have determined what the final product should be, select the camera system, equipment, and other necessary materials. Then work with the pilot to determine the flight plan. Planning the flight requires that you be able to use the grid system to locate and mark targets on a map.

12-7. The Aerial Mission

An aerial mission involves planning, photographing, keeping records, and coordinating actions between the pilot and photographer.

a. The pilot and photographer must work together as a team. The pilot's job is to get the photographer and his equipment to the target and back home safely. He knows his aircraft and what to do in an emergency. He must be familiar with the details of the mission and know just exactly what you intend to do so that you may obtain the desired photographs.

b. You must, of course, thoroughly check the camera system before the flight. Make sure you have all necessary equipment and that everything is working.

c. During the flight, help the pilot locate and line up the target. Also, operate the manual camera controls, and take the notes you will need for your records and captions.

d. On the return flight (or as soon as you can), complete the photographic log while the mission is still fresh in your mind. Start processing the film immediately after the flight.

CHAPTER 13

TYPES OF AERIAL PICTURES AND CAMERA SYSTEMS

Section I. TYPES OF AERIAL PICTURES

13-1. Introduction

The Army uses aerial photography to obtain information about enemy defenses, concentrations, and movements; to observe the terrain of future battle and occupation sites; and to study the effectiveness of our own defenses and weapons. The aerial photographs you obtain must meet these objectives and be worth the effort and danger involved. They should be sharp, detailed, and properly composed. In this chapter we'll discuss how to select the best type of aerial shot for your assignment and the proper film and camera system.

13-2. Composing an Aerial Photograph

a. When you compose an aerial photograph, you are also selecting the image size, camera angle, and exposure time. The target and purpose of the picture will guide you in determining what the proper composition should be.

(1) *Image size.* A minimum image size is required to locate or identify large objects on a photograph. Small objects and great detail require large image sizes. You can obtain the proper image sizes on your photographs by selecting the proper altitude for the aircraft and lens focal length.

(2) *Camera angle.* The camera angle depends on the direction that you point the camera out of the aircraft. It determines the view you will see in the print. For example, a view from directly above will look like a map, and a view from the side will look somewhat like a natural eyeview.

(3) *Exposure time.* You must use the correct exposure time to make sure that the area and objects of interest are in the picture. Also, in a sequence of exposures, each photograph must have the correct relationship to the others in the sequence. It's important to make exposures at the correct time of day so that you capture the specific activity on the ground or achieve the most effective shadowing.

b. We will discuss eight types of aerial photographs in the following paragraphs—pinpoint, stereo, strip, mosaic, vertical, low oblique, high oblique, and horizontal. We'll describe the characteristics of each type and then tell you what techniques you should use to obtain each.

13-3. A Pinpoint is a Single Photo

a. When you photograph a small target, as tiny as a pinpoint on the map, from the air, the photograph is called a *pinpoint* aerial photograph. You usually take a pinpoint when the target, such as a building, a weapon, or a small encampment, is small enough to be included in one exposure (fig. 13-1).

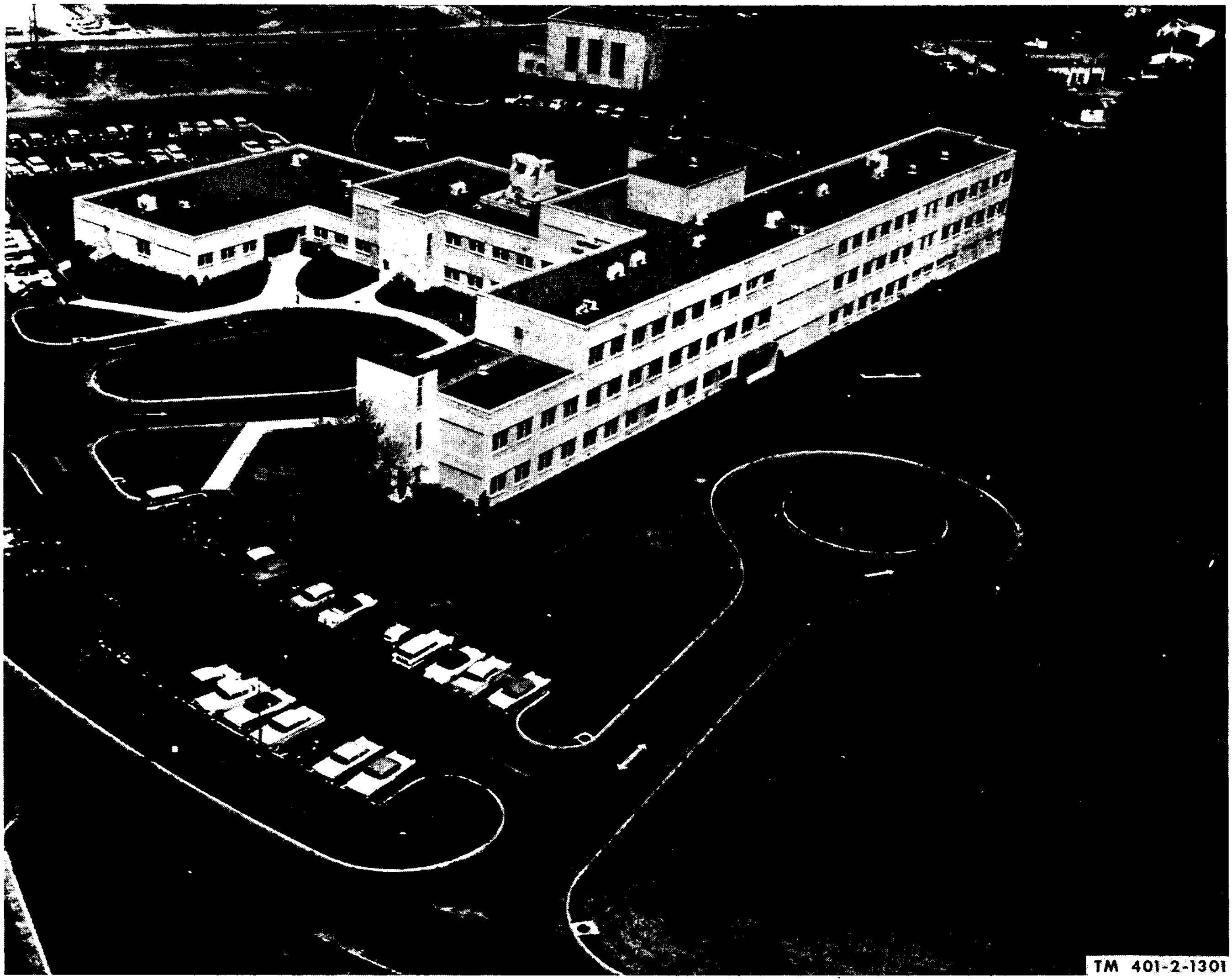
b. You can make more than one exposure of a pinpoint target to show the target from different angles. For instance, you might need two, three, or four pictures to show the different sides of a building; or you might make a near and a distant view of the pinpoint traget, one to show detail and the other to show the environment.

c. You can make more than one exposure to produce one large detailed picture of a pinpoint target. *For example,* you may need three exposures to give a large detailed view of both ends and the middle of a bridge. If the size and number of exposures are small, the total composition may be called a pinpoint aerial photograph, but technically it would be called either a strip (para 13-9) or a mosaic (para 13-11).

d. You usually take pinpoint aerial photographs with a manual rather than an automatic camera system. Because of the small size of pinpoint targets (fig. 13-1), you might have to make last minute camera adjustments to get the desired results. It is easier to do this on a manual camera because it is more flexible than an automatic one. However, you can use automatic camera systems for pinpoints. We will discuss the use of camera systems more completely in paragraphs 13-20 through 13-24.

13-4. Stereo Provides Depth

a. Two pictures of the same subject, properly photographed, can provide a stereoscopic or three-dimensional effect. The two pictures are called a *stereo,* a *stereopair,* or a *stereogram.* The word stereogram indicates that the two pictures are mounted and ready for stereo viewing. Normal human vision of objects is stereoscopic, each eye



TM 401-2-1301

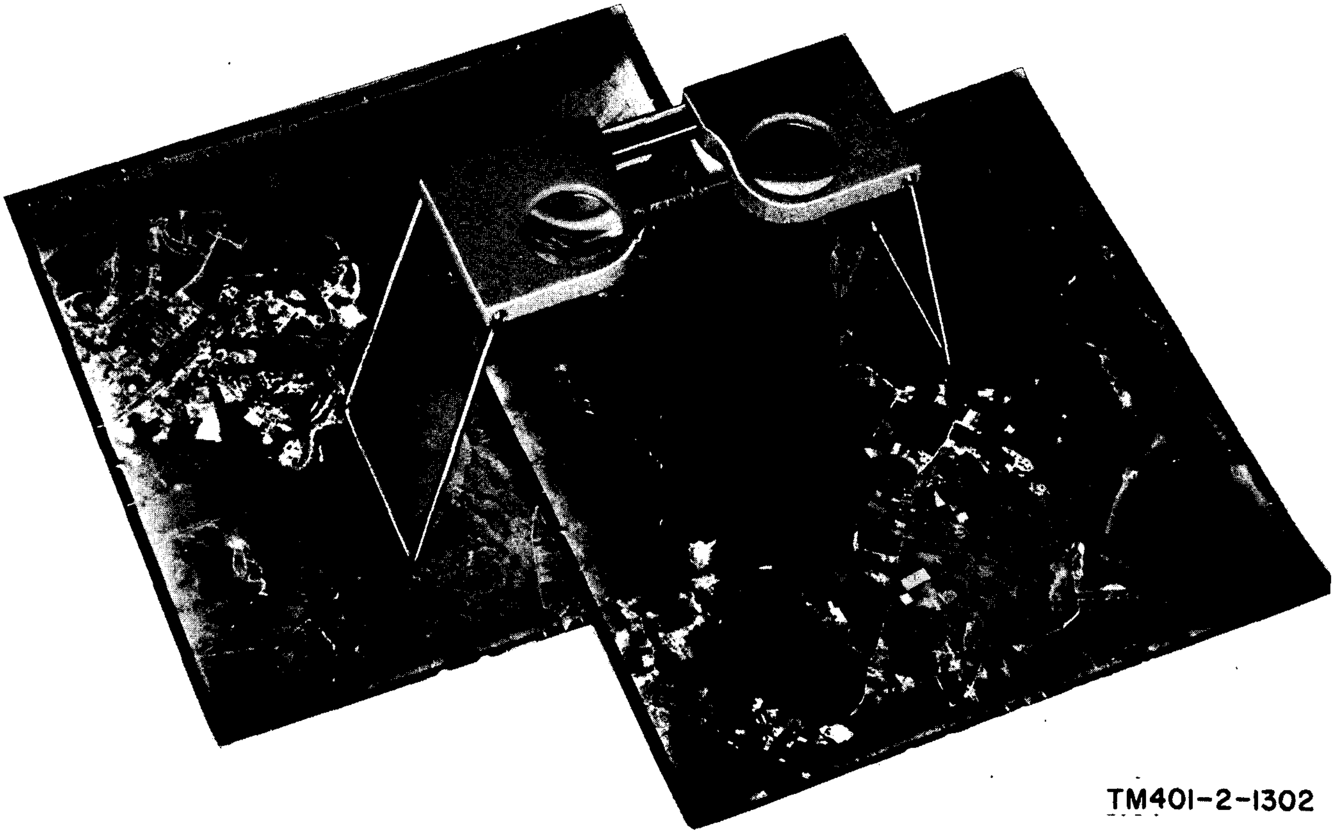
Figure 13-1. A pinpoint.

forming one of the two pictures. Thus, stereo pictures are lifelike.

b. When the two pictures are correctly spaced, you can, with some effort, see the pair in stereo. However, it is much easier if you use an optical aid called a stereoscope. The stereoscope controls the view so that you see one picture with the right eye and the other picture with the left eye. Figure 13-2 shows a stereoscope placed on a stereopair.

c. To produce a lifelike picture is not the primary purpose of taking Army aerial stereopairs. The primary purpose is to make measurements, such as height and depth, and detect features that are not visible on a regular photograph. These measurements are possible on stereopairs because of the slight difference between the two pictures. Photo interpreters are specially trained in stereo techniques to detect these fine points.

d. You make stereo photographs by taking two pictures of the same subject from slightly different positions. If the pictures were made from the same position, the two would be identical and there would not be any stereo effect. A very small shift in the camera position, between exposures, produces a very shallow stereoscopic depth. As you increase the shift in camera position between exposures, the apparent depth of the stereoscopic view increases. When the stereo effect is exaggerated so that hills appear steeper and depressions appear deeper than they really are, because the distance between exposures is great, the effect is called *hyperstereoscopy. Inverted stereo, pseudo stereo,* and *reverse stereo* all refer to the effect of interchanging the position of the pictures, causing hills to look like valleys and valleys to look like hills.



TM401-2-1302

Figure 13-2. Placement of a stereoscope.

13-5. Stereo Separation Equals Separation of Eyes

a. The stereoscopic effect is based on normal operation of human eyes. Each eye is, in effect, a camera that sees a scene from a slightly different position than the other.

b. Special cameras are made for stereo, and adapters are made for other cameras so that you can produce stereos with a single click of the shutter without moving the camera. These special cameras either use two lenses to produce two exposures at the same time, or they use mirrors that make a single lens react as two lenses. However, you can make stereos without special cameras or adapters.

c. Automatic aerial camera systems provide overlapping exposures suitable for stereo reproduction. When the camera is operating automatically, each exposure usually contains 60 percent of the scene on the previous exposure. In other words, a second exposure is made when the camera has moved far enough to shift the scene 40 percent. Adjacent aerial exposures make good stereopairs when there is a 60-percent overlap.

13-6. Making Stereos With a Manual Camera

a. Automatic film advance is essential for making aerial stereos because any camera movement, other than the shift required for the stereoscopic effect, will probably destroy the capability for stereo reproduction. Normally, you should hold the camera still through both exposures while the aircraft moves both you and the camera.

b. The distance from the camera to the scene must be the same for both exposures, and the stereo shift must be sidewards. Remember, stereo is like seeing—your eyes are side by side, not one in front of the other or one above the other, and both are the same distance from the scene.

c. As the aircraft moves the camera, you obtain the proper separation either by timing the interval between exposures or by watching the scene in the viewfinder.

13-7. How to Calculate Stereo Interval

a. The simplest method of producing an aerial stereopair is to provide a 60-percent overlap between exposures. To get a 60-percent overlap, the camera must move 40 percent of the ground dis-

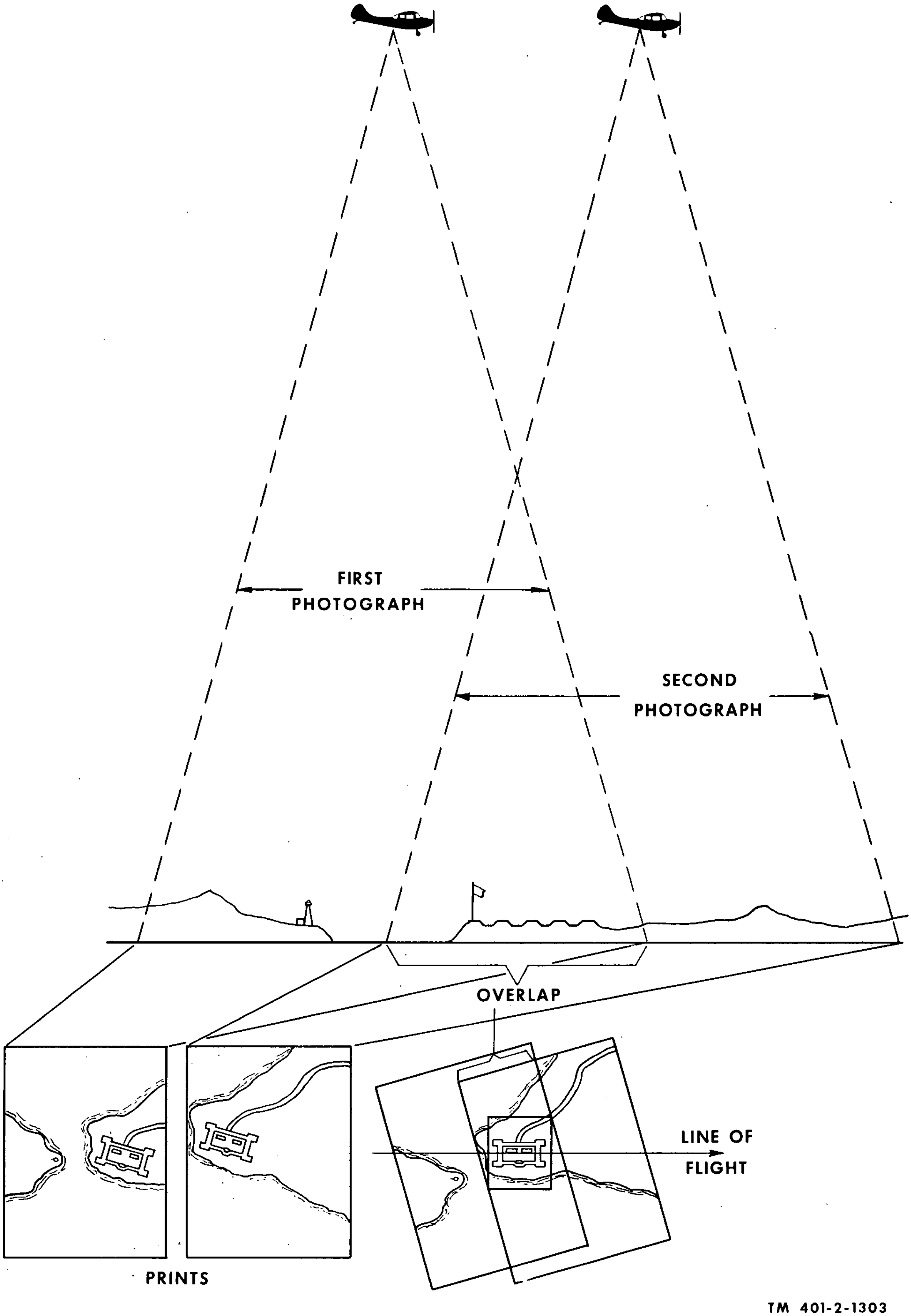


Figure 13–3. Exposure overlap.

tance covered on one exposure (fig. 13–3). The distance that the camera moves between exposures is called the ground gain forward (GGF).

b. For a 60-percent overlap the GGF equals 0.40 sA/f where s is the length of the film format in the direction that the aircraft is flying, A is the altitude, and f is the focal length of the lens. For a 5- by 5-inch format, with a 6-inch focal length, and at an altitude of 1,200 feet, the GGF for 60-percent overlap is 0.40 x 5 x 1200/6 feet. This figures out to 400 feet.

c. The time interval between exposures is equal to the GGF divided by the groundspeed of the aircraft. If you assume that the groundspeed for the aircraft is 100 knots, the interval for a GGF of 400 feet is 400/(100 x 1.69) seconds. The 100 was multiplied by 1.69 to change knots into feet per second because the GGF was in feet. You should find that the solution is 2.4 seconds.

d. A scale giving the conversion of nautical miles per hour (knots) and statute miles per hour to feet per second is in figure 13–4. The scale shows that 6 statute miles per hour (mph) is 8.8 feet per second. By multiplying both scales by 10 you get 60 mph = 88 ft/sec, and multiplying by 100 you get 600 mph = 880 ft/sec.

13–8. Visual Calculation of Interval

a. You can visually determine the time interval between exposures for a stereopair. Before the fight, mark your viewfinder to show the distance some object must move in the viewfinder to move the image 40 percent of the width of the film format. During the flight, take the first exposure, hold steady, and take the second exposure after some point in the scene has moved the distance marked on the viewfinder.

b. The marks are the same for any aircraft speed or altitude. However, you must change them when you change either the film format size or the focal length of the lens, if your viewfinder is a separate optical system.

13–9. A Strip is a Series of Overlapping Photos

a. A *strip* or *line overlap* (fig. 13–5) is a series of overlapping exposures matched together to form one long picture. A strip is best when your assignment calls for photographing long, narrow targets such as railroads, highways, coastlines, rivers, and mountain ridges.

b. You may hold the camera at any angle when making a strip; however, exposures made with the camera looking straight down from the aircraft join together better and have the most constant scale. To produce one long, continuous picture with many negatives requires a careful matching of images where one negative ends and the next begins. Because the camera is in a different position for each exposure, a perfect match is impossible. But, by overlapping exposures and using only the central part of each negative, you can obtain a nearly perfect result.

c. Photographing a strip (fig. 13–6) is a mechanical job, once the strip is started, because the aircraft flies at a constant speed and a constant altitude. You should not alter the camera during the strip, and you should make the exposures at regularly spaced intervals. Thus, the longer the strip, the more an automatic camera system is preferred.

13–10. Making a Strip

a. The camera-to-scene distance must remain constant while you're making the strip. Any change in distance will change the image size and make matching adjacent exposures impossible.

b. There are three reasons why you should make certain the overlap of adjacent exposures is almost always 60 percent.

(1) With a 60-percent overlap the final print can be made using only the central 40 percent of each negative. This permits better matching of negatives and a more constant scale. The central section is called the usable part (fig. 13–6), and its length is the usable distance of film forward (inches).

(2) Every point in the scene should appear on at least two negatives, and most points will appear on three. Thus, a lost or damaged negative here and there will not affect the mission.

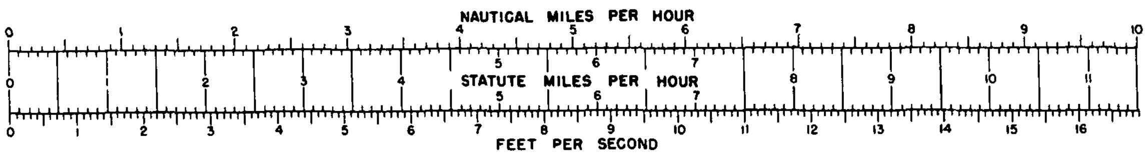


Figure 13–4. Knots and miles per hour to feet per second.

Figure 13-5. A strip.

(3) In addition, a 60-percent overlap allows you to use adjacent exposures for stereo reproduction.

c. The minimum number of exposures required for a strip is equal to the GGF (para 13-7*a* and *b*) divided into the ground length of the strip. Add two extra exposures, one at each end, to assure complete coverage. Let's determine the number of exposures you need to make a strip of a road 2 miles long with a 9- by 9-inch format, through a 6-inch lens, at an altitude of 1,200 feet, and with a 60-percent overlap.

GGF = 0.40 x 9 x 1200/6 = 720 feet
No. exposures = (2 miles/720 feet) + 2
No. exposures = (2 x 5280/720) + 2
No. exposures = 14.7 + 2 = 16.7

It's not possible to take part of an exposure, so you'll need 17 exposures.

13-11. A Mosaic is More Than One Strip

a. Large land areas are photographed in strips that overlap sideways. The strips are pieced together to form one large composite picture called a *mosaic.* This procedure assures greater definition than is possible with a single high altitude, wide-angle exposure.

b. Make each exposure from the same altitude and with the camera looking straight down from the aircraft. You can make mosaics with the camera pointed at some angle other than straight down, but the greater the angle the more difficult it will be to match adjacent exposures and make them appear as one.

c. The amount of side lap is usually 40 percent. Thus, with each new strip there is a ground gain sideways (width of new ground included in the exposure) of 60 percent of the width of the amount of ground covered in one exposure (fig. 13-7). You calculate the ground gain sideways (GGS) or lateral gain by multiplying together the percent *not* overlapped sideways, the width of the film format, and the aircraft's altitude, and then dividing by the focal length of the lens.

d. The number of strips required for a mosaic is equal to the width of the ground area covered divided by the GGS. Add one extra strip to assure complete coverage.

13-12. Making a Mosaic

a. Before you photograph an area for a mosaic you should square the area to be photographed. Do this by drawing (on a map) a rectangle that will include the area. Photograph a rectangular area of the ground because it is much

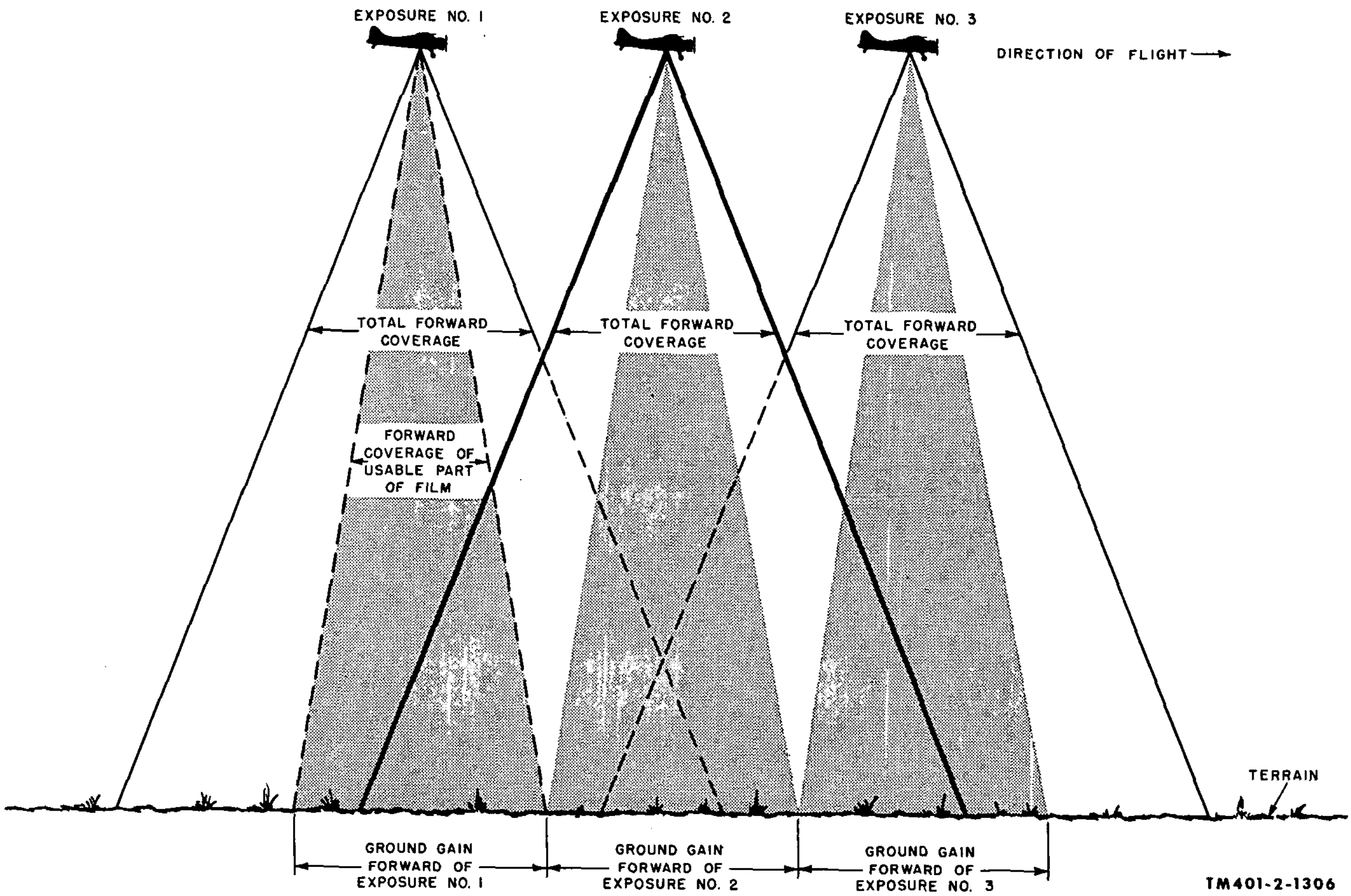


Figure 13-6. Making a strip.

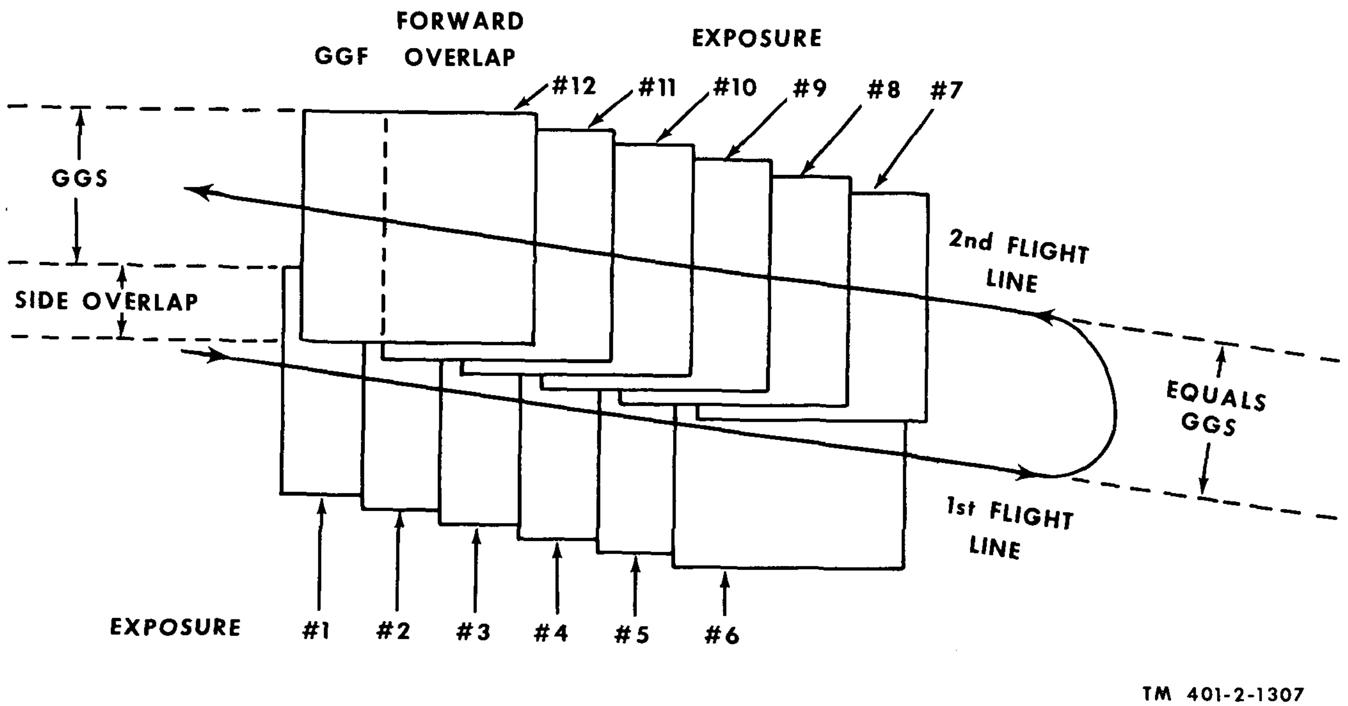


Figure 13-7. Making a mosaic.

easier to cover than some oddly shaped area.

b. Photograph the selected ground area in strips (fig. 13-7). The center of the first strip should pass directly over one of the longer edges of the rectangle; it doesn't matter which edge. The second strip is parallel to and overlaps the first strip so that the centers of the strips are separated by a distance equal to the GGS. Each of the following strips is parallel to and overlaps the preceding strip just as the first two do. If the area is a whole number of GGS's wide, then the center of the last strip passes over the edge of the rectangle opposite the edge covered by the first strip. Otherwise, the center of the last strip lies outside the rectangle.

c. Throughout the photographing of an area for the purpose of making a mosaic, you should always keep the camera the same distance from the scene. The distance is nearly always the aircraft's altitude because mosaics are almost always made from photographs taken straight down from the aircraft with an automatic camera system. Table 13-I tells you what information you must have for taking photographs to prepare a photo mosaic and how you get the information.

13-13. A Vertical is a Photo Taken Straight Down

a. An aerial photograph taken with the camera pointing straight down from the aircraft is called a *vertical* (fig. 13-8). Verticals are used for mak-

Table 13-I. Information You Need for Photographs Required to Make a Mosaic

Factors	How to get the information
Location of target area	Indicated on pilot's map by requesting authority.
Length of target area (ft)	Furnished by requesting authority.
Width of target area (ft)	Furnished by requesting authority.
Scale desired	Furnished by requesting authority.
Focal length (in.)	Obtain from lens to be used on mission.
Altitude (ft)	$\frac{\text{Focal length (in.)} \times \text{scale desired}}{12}$
Film size (in.)	Obtain from camera to be used on mission.
Forward overlap (%)	60% is standard.
Usable distance of film forward (in.).	If 60% standard overlap is used, take 40% of the length of film in the direction of flight.
Ground gain forward (GGF) (ft).	$\frac{\text{Usable distance of film forward (in.)} \times \text{altitude (ft)}}{\text{Focal length (in.)}}$
Number of exposures per run	$\frac{\text{Length of area (ft)}}{\text{Ground gain forward (ft)}} + 2$
Minimum length of film per run (ft).	$\frac{\text{Number of exposures per run}}{\text{Number of exposures per foot}}$
Knots made good (KMG):	
Odd-numbered runs	Airspeed in knots plus correction for winds at odd-numbered run heading.
Even-numbered runs	Airspeed in knots plus correction for winds at even-numbered run heading.
Interval between exposures:	
Odd-numbered runs	$\frac{\text{GGF (ft)}}{\text{KMG at odd-numbered run reading} \times 1.7}$
Even-numbered runs	$\frac{\text{GGF (ft)}}{\text{KMG at even-numbered run heading} \times 1.7}$
Side overlap (%)	40% is standard.
Usable distance of film sideways (in.).	If 40% side overlap is used, take 60% of the width of film at right angles to the direction of flight.
Ground gain sideways (GGS) (ft).	$\frac{\text{Usable distance of film sideways (in.)} \times \text{altitude (ft)}}{\text{Focal length (in.)}}$
Number of runs	$\frac{\text{Width of area (ft)}}{\text{Ground gain sideways (ft)}} + 1$
Distance between flight lines (in.)	$\frac{\text{Ground gain sideways (ft)} \times 12}{\text{Scale of pilot's chart}}$

ing strips and mosaics because they show the layout of the land and can be easily pieced together to form large composite pictures. Verticals are also used as maps or with maps for planning attack routes, directing weapon fire, laying out future campsites, etc.

b. In a vertical photograph, the lens axis is perpendicular to the surface of the earth. The photograph usually covers a relatively small area shaped approximately like a square or rectangle. Being a view from above, it gives an unfamiliar view of the ground because relief is not readily apparent. Distances and directions in verticals may approach the accuracy of maps if the aerial photographs are taken over flat terrain.

c. The entire view in a vertical is not perfectly flat because only the very center is taken straight down. A building in the center of a vertical shows only its roof, but a building near the edge of the picture shows the sides in addition to the roof (fig. 13-8). Although this slight change in viewing angle from center to edge is undesirable when you try to match negatives for strips or mosaics, it does provide the necessary differences in photographs for stereo.

13-14. What is an Oblique?

a. An *oblique* photograph is made with the camera looking out and down from the aircraft although *not* straight out and *not* straight down. For accuracy we state the obliqueness in degrees. The angle between the camera axis (or optical axis) and the horizontal is called the *angle of depression;* straight out, parallel to the ground is 0 degrees, and straight down, perpendicular to the ground is 90 degrees. The angle between the camera axis and the vertical is called the *tilt angle* and is the complement of the angle of depression.

b. Obliques may be anywhere between 0 and 90 degrees and are divided into two categories—low and high. The distinguishing characteristic

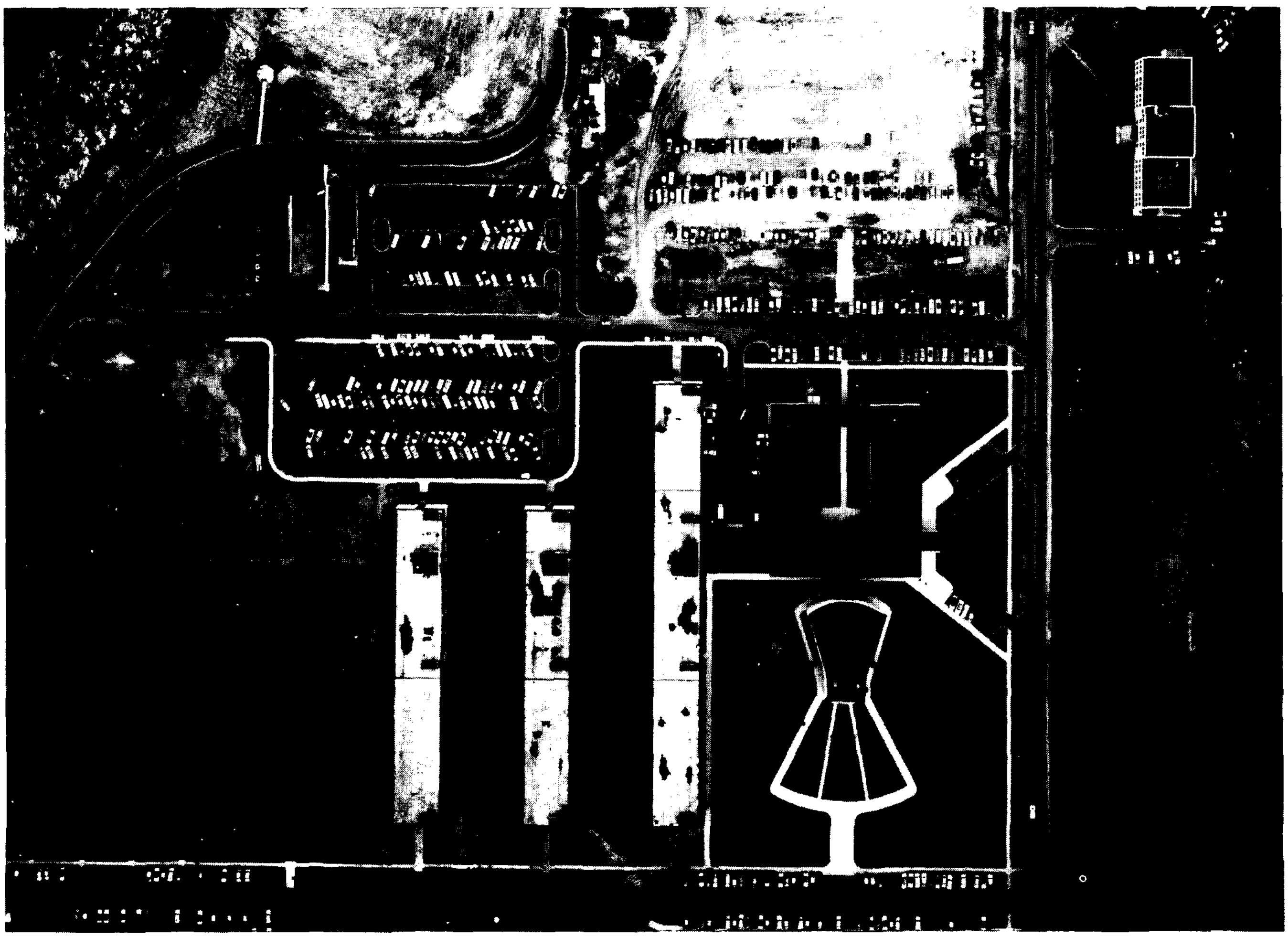


Figure 13-8. A vertical.

between the two categories is the horizon. The horizon is visible in high obliques but not in low obliques (figs. 13-9 and 13-10).

13-15. Low Oblique Shows no Horizon

a. A low oblique (fig. 13-9) does not show the horizon. It is taken with the camera inclined about 30° from the vertical. A low oblique provides the photo interpreter with a view that shows the sides of buildings but still retains most of the map qualities. Obliques do *not* have a uniform scale, and they do *not* make good strips or mosaics. A low oblique covers a relatively small area that is shaped like a trapezoid. The objects look more familiar than in a vertical, as if you were viewing them from the top of a tall building.

b. In your aerial photographic work, take low obliques for routine reconnaissance to spot terrain and installation changes. In a systematic search of a large area, an automatic camera system is preferable for making obliques, while with more specific targets a manual camera is preferable because it is more flexible.

13-16. High Oblique Includes the Horizon

a. A high oblique is taken at an angle that includes the horizon, about 60° from the vertical. It gives much the same view that a pilot would have when approaching a target. As such, high obliques are useful in guiding pilots toward a photographic target, a bombing target, or a helicopter landing site.

b. High obliques taken at low altitudes are similar to the view you see from the top of a tree or a hill (fig. 13-10). They cover a large area that is shaped like a trapezoid. It is easier for a man on the ground to locate and identify objects in a high oblique picture than in a low oblique or a vertical air picture. High obliques aid or supplement ground reconnaissance.

13-17. Horizontal Aerial Photographs

To show the sides of hills, buildings, dams, bridges, and the like, take a *horizontal aerial photograph* with the camera pointing straight out the window of a low flying aircraft. This type of picture has the advantage of being nearly identical to the view from the ground. However, the low altitude required for taking the photograph is extremely dangerous to fly, especially over enemy territory. Helicopters have an obvious advantage over other types of aircraft in horizontal aerial photography because they can fly very low. Horizontals are usually pinpoint aerial photographs, but they can also be short strips.

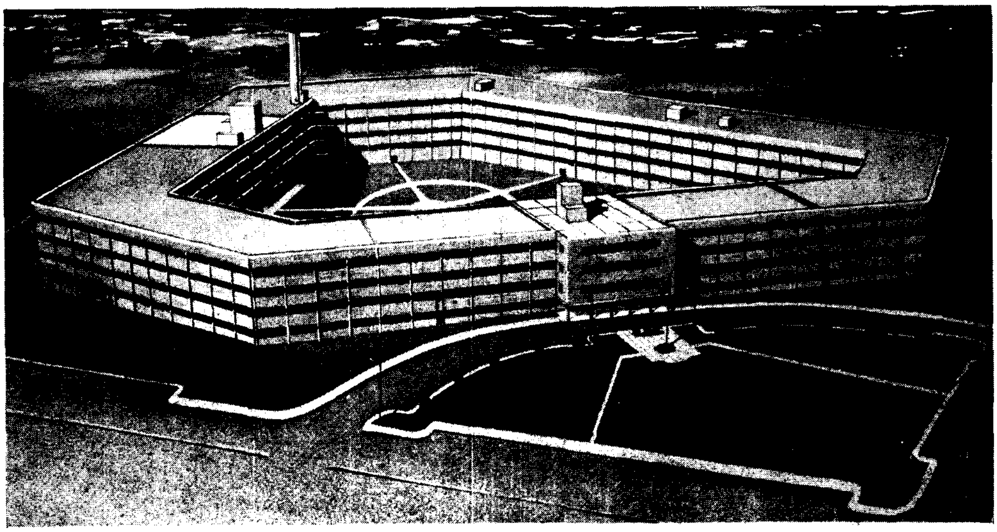
13-18. Summary of Section I

a. A *pinpoint aerial photograph* is an aerial picture of a small target, usually completed in a single exposure.

b. A *stereopair* is two pictures of the same subject taken from slightly different positions. You can see lifelike, three-dimensional images when the pair is combined to form a *stereogram* and viewed with a *stereoscope.*

c. *Hyperstereoscopy* is an exaggerated stereo effect where the apparent depth is increased.

d. *Overlap* is the amount of the same scene that appears on two photographs for stereos, strips, and mosaics. Aerial stereopairs and adjacent exposures of a strip generally have 60-percent overlap.



TM 401-2-1309

Figure 13-9. A low oblique.

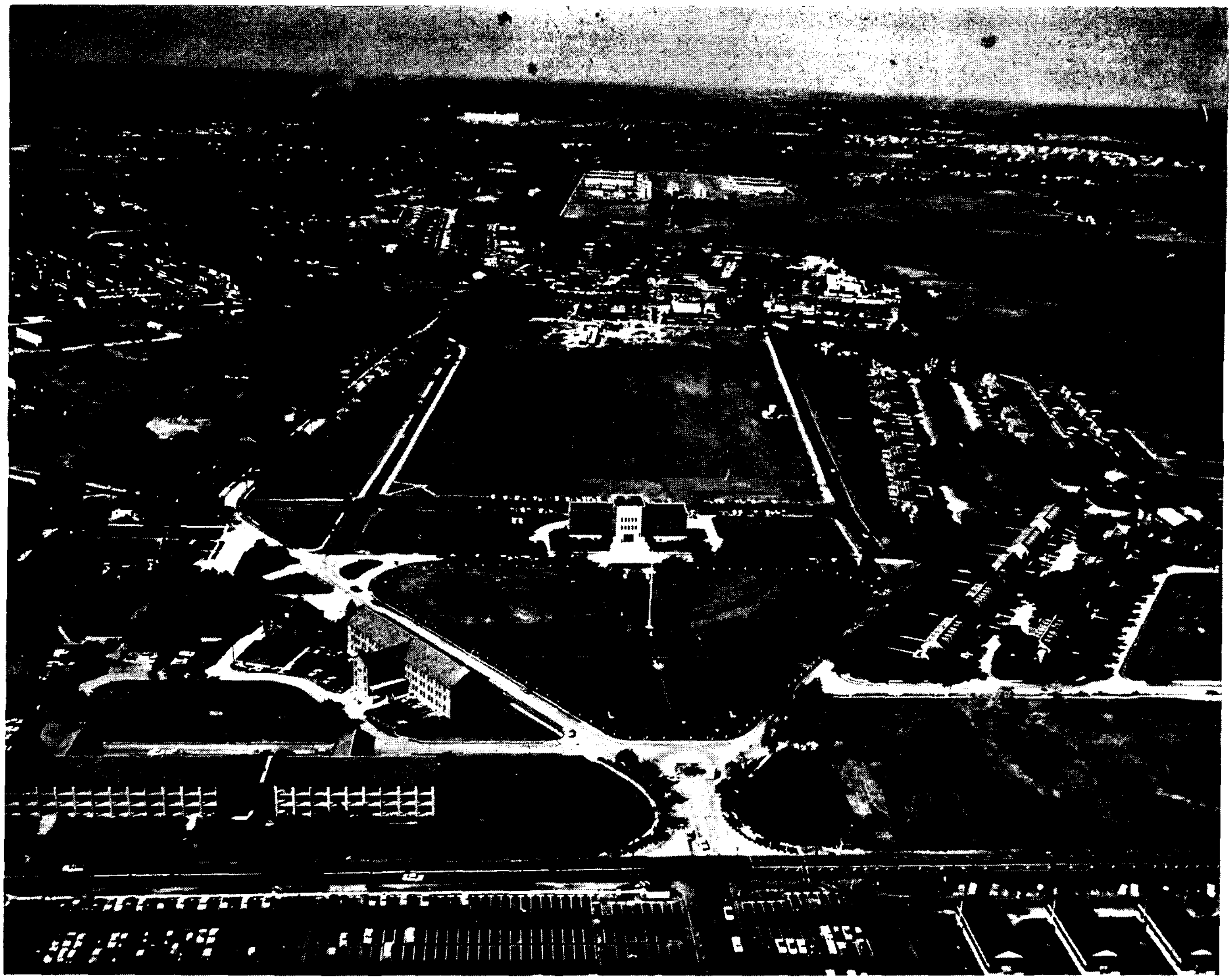


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Figure 13-10. A high oblique.

e. GGF or ground gain forward is the distance the camera moves between exposures. It is equal to the distance on the ground *not* in the previous exposure when the two exposures overlap. With vertical aerial photography the GGF equals the percentage *not* overlapped times the length of the film format in the forward direction, times the altitude divided by the lens focal length.

f. Interval is the time between exposures. It equals the GGF divided by the groundspeed of the aircraft.

g. A *strip* is a long, narrow picture made from a series of overlapping exposures. The number of exposures necessary equals the ground length of the strip divided by the GGF. You add two extra exposures to make sure there are enough.

h. A *mosaic* is a picture made from overlapping strips. The amount of side overlap is usually 40 percent.

i. GGS (ground gain sideways) or lateral gain on a strip is the distance on the ground that is not covered by the adjacent overlapping strip. GGS is equal to the percent *not* overlapped times the width of film format (sideways), times the altitude divided by the focal length of the lens. The number of strips required for a mosaic is one plus the ground width of mosaic divided by the GGS.

j. A *vertical aerial photograph* is an aerial photograph made with the camera looking straight down from the aircraft.

k. A *low oblique* is an aerial photograph looking down and out from the aircraft at an angle. It does not include the horizon. The picture has maplike qualities but it is not flat.

l. A *high oblique* is an aerial photograph looking out and down from the aircraft at an angle. It includes the horizon and is more a side view than an overhead view.

m. A *horizontal aerial photograph* is an aerial side view and has much the same appearance as a photograph taken from the ground.

n. The *angle of depression* is the angle between the camera axis and the horizon in oblique aerial photography.

o. The *tilt angle* is the angle between the camera axis and the vertical in oblique aerial photography.

Section II. AERIAL FILMS AND CAMERA SYSTEMS

13–19. Types of Film

a. Aerofilm. You can use any type of film for aerial photography, but there are special films made with a low-shrinkage (topographic) base. In general photography, shrinkage is not a problem because after the film is properly processed, an unaided eye does not notice the distortion. In mapping and aerial reconnaissance, however, photo interpreters often need to make accurate measurements on the photographs. Because of this, you will have to use aerofilm for some missions. Even when film with a topographic base is required, you still have a wide choice of film.

b. Class L Film. Kodak Super XX Aereographic is a high-speed, panchromatic emulsion film used for daylight photography. Its ASA rating is 100. It has a good exposure latitude, high resolving power, low graininess, and normal contrast. Its color sensitivity is equal to that of panchromatic C film.

c. Class N Film. Kodak Tri-X Aero Pan is an extra high-speed, panchromatic emulsion film used primarily for night photography and for poor light conditions. Its ASA rating is 200. Although it gives better shadow detail than the Super XX, the grain is coarser.

d. Class K Film. This is a high-speed, high-contrast, infrared-sensitive emulsion film that you can use day or night. When used with a Wratten 89A or 25A filter, it produces an infrared picture. The advantages of infrared in aerial reconnaissance are its ability to detect camouflage and to penetrate haze.

e. Color Film. Ektachrome Aero Type 8442 for color transparencies, and Ektacolor Aerial Film SO 276 for color negatives, are just two of the many color films available for aerial photography. Ektachrome Infra-Red Aero is a color film with an infrared-sensitive layer that makes the film useful in detecting camouflage.

f. Select the Proper Film. There are enough types and sizes of aerial films to fit almost any need. Select one that best suits your need based on the purpose of the mission and use of the final pictures. If the purpose is to detect camouflage, then use infrared film. In a night mission use class N film. For a briefing, color transparencies may be just the thing.

13–20. Kinds of Aerial Camera Systems

An aerial camera system may simply consist of a camera just like the one you would use on the ground, or it may be a complex, electronically controlled system. In the following discussion of the differences and uses of the camera systems, we will consider three kinds.

a. Manual. The photographer directly operates all of the controls (para 13–21).

b. Automatic. Electronic devices completely operate the camera (para 13–22).

c. Semiautomatic. Electronic devices control some of the camera operation (para 13–23).

13–21. In Manual Systems the Photographer Has Control

a. A manual aerial camera system is the same as a camera you would use on the ground. It is generally hand-held, but a mount for it could be built into the aircraft. Usually, you take pictures through the side window with the camera pointed slightly toward the rear to avoid including a wingtip or other part of the aircraft in the picture. However, you can take the pictures through other windows, depending on the aircraft. *For example,* helicopters have a clear view forward, and some planes have floor windows for vertical pictures.

b. Taking a picture from an airplane is like taking a picture of a moving object. As the plane moves forward the image moves forward on the film causing a blur. Three methods are used to overcome this blur to produce clear, sharp pictures—

(1) Use a fast shutter speed to allow little time for image motion.

(2) Pan the camera to prevent the image from moving with respect to the film.

(3) Use a camera equipped with an image motion compensation mechanism. This moves the film with the image so that the image remains in the same position on the film.

c. Because of aircraft vibration, close quarters, and position of windows, you might have to assume odd positions to get the proper view and hold the camera steady. With any hand-held camera, you should avoid touching the aircraft from your waist up to prevent camera motion due to aircraft vibrations.

d. Use a manual system for pinpoint aerial photographs, odd-angle oblique pictures, and exploratory missions because you can completely control the camera throughout the mission. With a manual system, you can make last minute changes in the camera angle, lens, filters, and exposure. Normally you plan each step of the mission before the flight. Occasionally, however, you have to omit some detail in the plan until you reach the target because sufficient data is not available beforehand.

13–22. Electronic Controls Operate Automatic Systems

a. Automatic camera systems are designed for use in drones, although they can be installed in piloted aircraft as well. Because drones carry no people, electronic control units operate the camera. Photographic missions with drones require very careful preflight planning. You have to determine the exposure sequence, load the camera, and set the controls before the flight.

b. Although you usually preset the exposure, many automatic systems use photocells to measure the actual lighting and readjust the amount of exposure. The control unit operates the shutter at regularly spaced intervals according to some preset schedule and the speed of the aircraft. The film automatically advances between exposures and automatically moves during the exposure to keep in step with image motion. Even though the camera operates electronically and adjustments are made automatically during the flight, you make the principal control settings before the flight.

c. The electronically controlled interval between exposures gives automatic systems the advantage over manual systems for producing overlapping aerial photographs. A machine-controlled exposure interval is much more accurate than an interval determined by human judgment and reaction.

d. Moving the film during the exposure keeps the image focused on the same spot on the film and prevents blurring the image. This is called image motion compensation (IMC). Here again, moving the film electronically is more exact and effective than having a photographer pan the camera to keep the image steady.

13–23. Semiautomatic Systems Combine Automatic and Manual Features

a. When an automatic camera system is installed in a piloted aircraft some manual controls are often included. You can operate part of the system manually and the other parts can be operated automatically. This is a semiautomatic system. There are also systems that operate only semiautomatically, giving you some freedom to change plans during the flight and still retain the precision required for overlapping aerial photography.

b. Semiautomatic cameras may be hand-held or mounted. The mounting is usually either in the aircraft's body or out on a wing in a container called a pod. The automatic part of the system always includes the film advance and usually includes IMC. A separate device, called an intervalometer, may be included to control the timing between exposures.

13–24. Aerial Photography at Night

a. Many aerial camera systems can be used in daylight and at night. Some systems, however, can be used only during the daytime because they have no means of providing light or synchronizing an exposure to a flash. Night photography requires artificial light.

b. To illuminate a large ground area from a high altitude requires more light than dozens of normal flashbulbs could supply. There are large electronic flash units for aerial photography, but the Army mainly uses flash cartridges. A common flare is the M–112 photoflash cartridge. It has a 4-second delay and provides a peak illumination of 50 million candlepower.

c. The open shutter technique and a photocell to control the exposure time can be used for aerial photography at night as follows.

(1) The shutter is opened and a photoflash cartridge is ejected from the aircraft.

(2) About 1 second later, the flash ignites. Light from the flash strikes the ground and returns to the camera.

(3) As the film is exposed, the photocell measures the intensity of the light.

(4) After the exposure time, a function of (3) above, elapses, the shutter is closed by an electronic control circuit.

Section III. SUMMARY AND QUESTIONS

13–25. Summary

We have discussed the types of pictures, films, and camera systems used in aerial photography. Table 13–II and figure 13–11 summarize the types, their characteristics, and their uses.

13–26. Review Questions

a. What type of aerial picture—

(1) Is most maplike?

(2) Shows the horizon?

(3) Gives a three-dimensional effect?

b. What type of aerial pictures should you take to—

(1) Measure the area and distances on an airfield?

(2) Measure the height of a building?

(3) Photograph a road?

(4) Produce routine reconnaissance photographs?

c. What class of aerial film should you use—

(1) For general purpose daylight photography?

(2) To detect camouflage?

d. What type of aerial camera system is best for—

(1) Vertical mosaics?

(2) An unplanned, odd angle photograph?

e. Your mission is to photograph an area of land for a photomap that can be used to plan the layout of a base camp. What is the best picture type, film, and camera system for the mission?

f. The Army suspects that the enemy has a new missile and launcher somewhere in a particular area. What is the best picture type, film, and camera system to photograph the weapon?

13–27. Answers

a. (1) Vertical.

(2) High oblique.

(3) Stereo.

b. (1) Vertical (or mosaic).

(2) Stereo.

(3) Strip.

(4) Low oblique.

c. (1) Class L.

(2) Class K.

d. (1) Automatic camera system.

Table 13–II. Aerial Picture Types

Type	General description	Use
Pinpoint	Single photograph	Small target.
Stereo	Two photos, three-dimensional viewing	Accurate measurement of depth.
Strip	Series of 60% overlapping photos	Long, narrow targets.
Mosaic	Series of 40% overlapping strips	Large target area.
Vertical	Camera looking straight down	Strips, mosaics, maps, and ground distance measurements.
Horizontal	Low altitude, side view	Side view of ridges and bridges, occasional strips.
Low oblique	Camera looking down and out at an angle, no horizon	Routine reconnaissance.
High oblique	Camera looking out and down at an angle and includes the horizon.	To aid or supplement ground reconnaissance.

Aerial Films

Type	General description	Use
Class L	Black and white, pan C	General purpose, daylight.
Class N	Black and white, panchromatic	General purpose, night.
Class K	Infrared	Detect camouflage.
Ektachrome	Color, positives	Transparencies and slides.
Ektacolor	Color, negatives	Color prints.
Ektachrome Infrared.	Color with infrared sensitivity	Detect camouflage.

Camera Systems

Type	General description	Use
Manual	Hand-held, operated by photographer, used in any aircraft.	Pinpoints, odd viewing angles.
Semiautomatic	Hand-held or mounted, generally includes electronically controlled film advance, IMC, and exposure interval; aircraft supplies power.	Any picture type.
Automatic	Mounted in or on aircraft (piloted and drones) and is electronically operated; built into special aircraft.	Strips, mosaics, and fixed views.

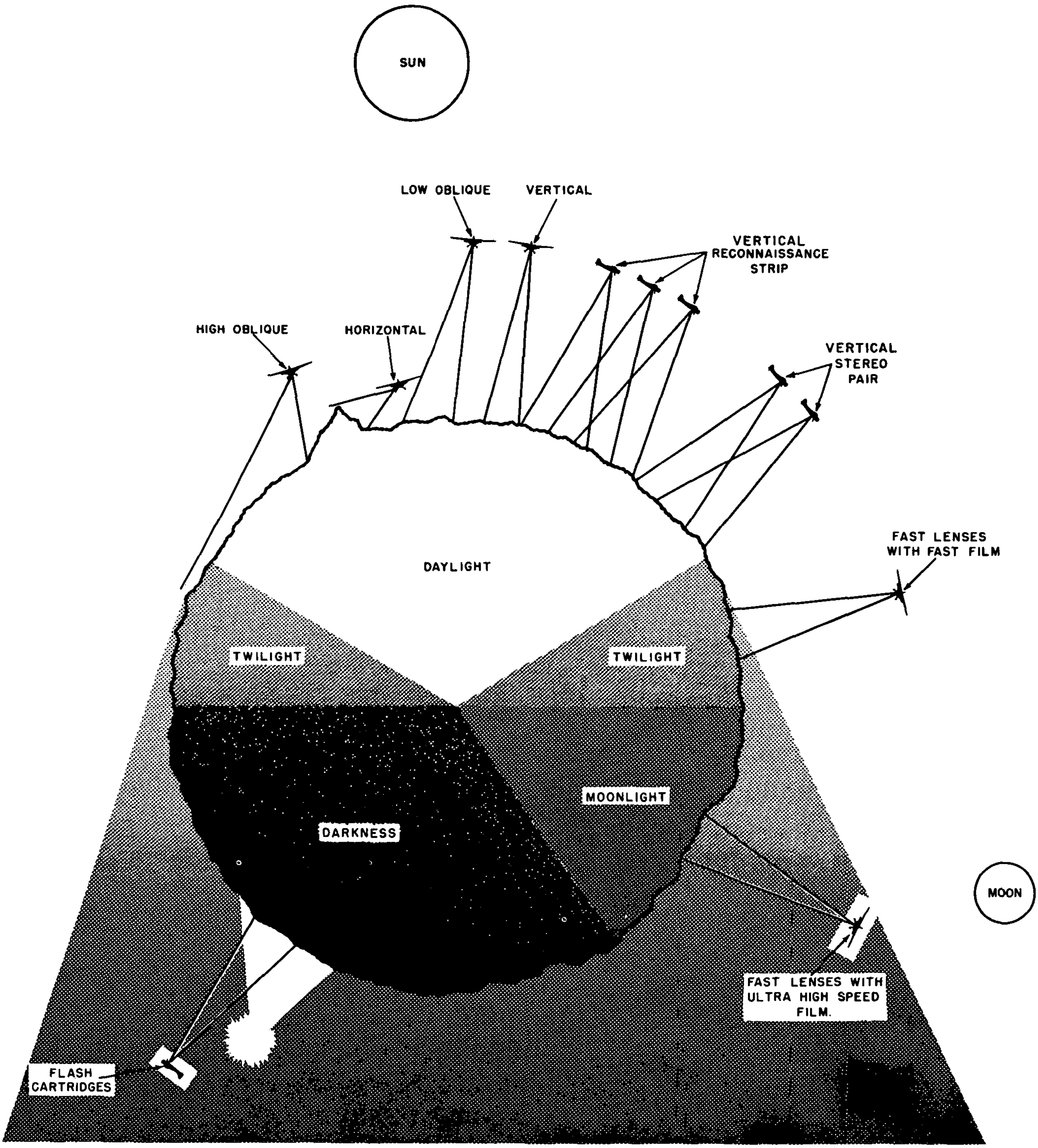

Figure 13–11. Aerial photography.

(2) Manual camera system.

e. Vertical mosaic, daylight pan (class L), automatic camera system.

f. Oblique (to get as much side view as possible), infrared (in case of camouflage), semiautomatic (for systematic coverage if weapon cannot be quickly pinpointed and hand-held to get the best view if weapon is visible).

CHAPTER 14

PLANNING AN AERIAL MISSION

14-1. Best Results Obtained by Planning

a. Army aerial photographic missions are flown to obtain information about enemy defenses or activities. Also, aerial photographs can show weaknesses in our own defenses and aid in planning our actions. Through the camera, the photographer takes those in command for a look either at the enemy's or at their own activities.

b. To get the most out of an aerial photographic mission you must carefully plan each step. The duration of the flight is usually short, and seconds are important, especially over enemy territory. You'll probably not be able to reshoot the mission, so your first attempt must be successful. Thus, you must plan the mission carefully before the flight.

c. To plan an aerial photographic mission, you must first define the final product; then determine the camera system, equipment, and materials required. Finally, you determine the flight pattern.

14-2. Mission Initiated by Request

Whenever an Army aerial photographic mission is flown, someone needs, has requested, and is waiting for the pictures. The requester tells what he needs, and it's up to you as the photographer to produce the most useful pictures possible. The first step toward topnotch results is good planning. To plan your assignment get the following information from the requester:

a. How Soon Does the Requester Need the Pictures? A photomap is worthless for tomorrow's trip if it takes a week to produce the map. Extreme urgency may require you to use a diffusion transfer (polaroid) system and material. And when there is no urgency, you might delay the flight until the weather conditions are ideal for flying and photography.

b. The Type and Location of the Target. Small targets require either low altitudes or long focal length lenses. Camouflaged objects can be seen with infrared film. Emergency plans are different over targets in enemy and friendly territory. The location of the target may demand a specific type of aircraft or a specific camera system.

c. The Type and Amount of Coverage. Fine detail requires a large-scale reproduction. Vertical mosaics are good for photomaps, while horizontal pictures give a more natural view. Large land areas require many exposures.

d. The Purpose and Use of the Final Prints. Planning attack routes or laying out campsites require photomaps and perhaps some obliques to show the variations in elevation. To study the enemy's movement at night means using a camera system than can take night pictures. Slides may be the best final product for a briefing.

e. Many Factors Affect Planning. As you can see from the items above, you need to consider many factors in your planning so that the final product will serve the user's needs.

14-3. First, Define the Final Product

Before performing any aerial photographing, you need a goal. The goal of an aerial photographic mission is pictures—pictures that meet the needs of the requester. When you plan an aerial photographic mission, describe the final prints by answering the following questions. Actually writing out the answers will aid you in your planning.

a. What is the picture content? If the print is maplike, define the area by stating its size, location, and boundaries. *For example:* photographed an area 6,000 feet long by 4,000 feet wide, grid coordinate 2623 on map sheet 6063 I; the area is bound by Pemberton-Wrightstown road to the east, Rancoss Creek to the north, dirt road to the west, and by an imaginary line just south of the airfield. If the print is a picture of an object, describe the object and the view in this manner: "A four-story builing with a good view of the front (high oblique)."

b. What is the image size or scale? Scale is the ratio of the image size to the actual object size. The ratio 1:600 is a large scale for an aerial photograph while 1:60,000 is a small scale. A building 50 feet (600 inches) long will measure 1 inch on the print with a scale of 1:600, and it will measure 1/100 inch when the scale is 1:60,000. The scale you should use depends on the size of the object and the amount of detail required. Figure 14-1 shows the minimum scale for identification (O) and the minimum scale for interpretation (●) of some common military photographic subjects.

c. Will the prints be in black and white or

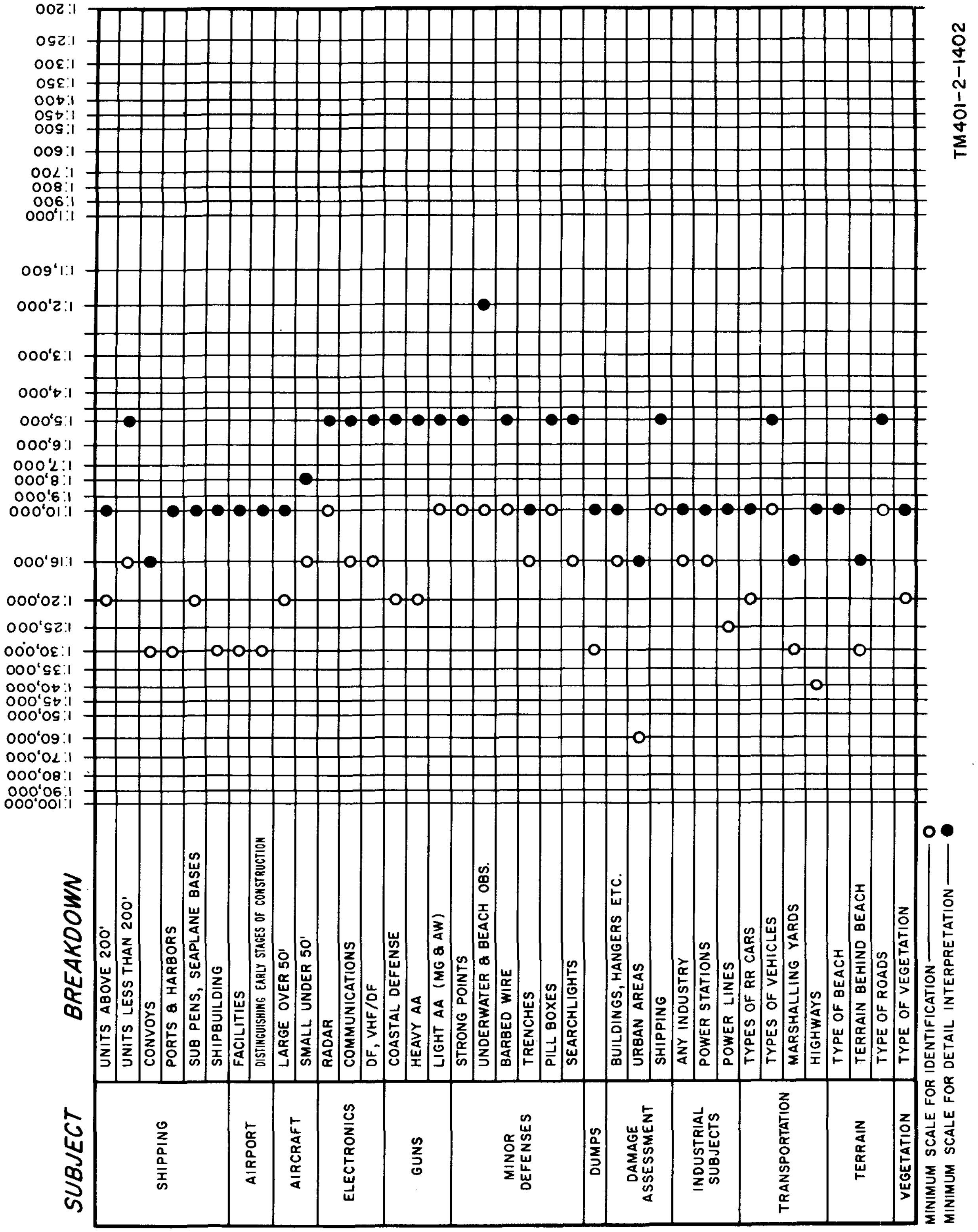

Figure 14-1. Minimum scales.

color? At present, black and white is the general purpose type of print, but color is fast becoming popular. You should make a note if the picture is to be an infrared photograph.

d. Will the prints be pinpoint pictures, stereopairs, strips, mosaics, or a combination of these?

e. Will the views be vertical, high or low oblique, horizontal, or a combination of these?

f. How many exposures are required? An accurate tally may not be possible at this point in your planning, but with experience you should be able to make a good estimate.

14-4. Next, Choose the Photographic System

a. In choosing a photographic system for an aerial assignment you are, of course, limited to what is available. In general, there is room for choice. Any camera you use on the ground may be used in the air, and most likely one or more aerial cameras are available.

b. Some systems cannot take aerial pictures at night. Thus, the time of the flight is an important factor to consider when you select the camera system.

c. A manual system is flexible, so you can alter your plans in midflight; it can be used in any aircraft and does not restrict your viewing angle. A hand-held semiautomatic camera has the flexibility of a manual system with the added feature of controlled exposure interval. Mounting the semiautomatic camera in a wing pod reduces some of its flexibility, but it results in better strips and mosaics. An automatic system is best for long strips and large mosaics.

14-5. Photographic Materials Required

After you have selected the specific camera system, you can select the other materials (film, lens, filters, flares, etc.) that are necessary for the mission.

a. Film size is determined by the camera you'll use. The class of film (N, L, K, or color) depends on the type of prints you will make (para. 14-3*c*). Calculate the amount of film from the number of exposures required (para. 14-3*f*).

b. The focal length of the lens depends on the scale (para 14-3*b*) and on the altitude of the flight. It is determined by multiplying the altitude by 12 (to change altitude from feet to inches) and dividing by the reciprocal of the scale. However, since your lenses usually have fixed focal lengths, you'll probably first select the lens, then multiply its focal length by the scale, and divide by 12 to determine the altitude. You determine the scale by multiplying the altitude by 12 and dividing by the focal length (fig. 14-2).

c. List all the material you'll need, and do not forget flares for night photography or filters for cutting haze.

14-6. Haze and Altitude Determine Filters

There are two main reasons for using filters in aerial photography: (1) to cut haze, and (2) to get a pure infrared photograph.

a. Infrared film is sensitive, as are all films, to ultraviolet. Use deep red or infrared (black) filters to absorb ultraviolet and blue, thus allowing only infrared to reach the film. You don't need haze filters when you use infrared filters because infrared filters absorb haze.

b. Regular film is more sensitive than the eye to haze so you may need a filter even though the sky looks clear. Distance increases the effect of haze because haze is produced by the atmosphere. Thus, you should select haze filters by the amount of visible haze and the altitude (distance from the scene) of the flight.

c. The following chart suggests the filter to use for air photographs. The chart differentiates between verticals and obliques because the angle of the oblique affects the distance to the scene.

Type	Altitude (feet)	No haze	Light haze	Heavy haze
Vertical	1,000	K-2	K-2	minus-blue #12
	2,000	K-2	K-2	minus-blue #12
	3,000-5,000	K-2	minus-blue #12	minus-blue #12 or red #25
Low oblique	1,000	K-2	K-2	minus-blue #12
	2,000	K-2	K-2 or minus-blue #12	minus-blue #12
	2,000-5,000	K-2	minus-blue #12	minus-blue #12 or red #25

Type	Altitude (feet)	No haze	Light haze	Heavy haze
High oblique	1,000	K-2	minus-blue #12	red #25
	2,000	minus-blue #12	minus-blue #12	red #25
	2,000-5,000	minus-blue #12	minus-blue #12	red #25
Infrared	All	red #25	deep red #70	very deep red #88A

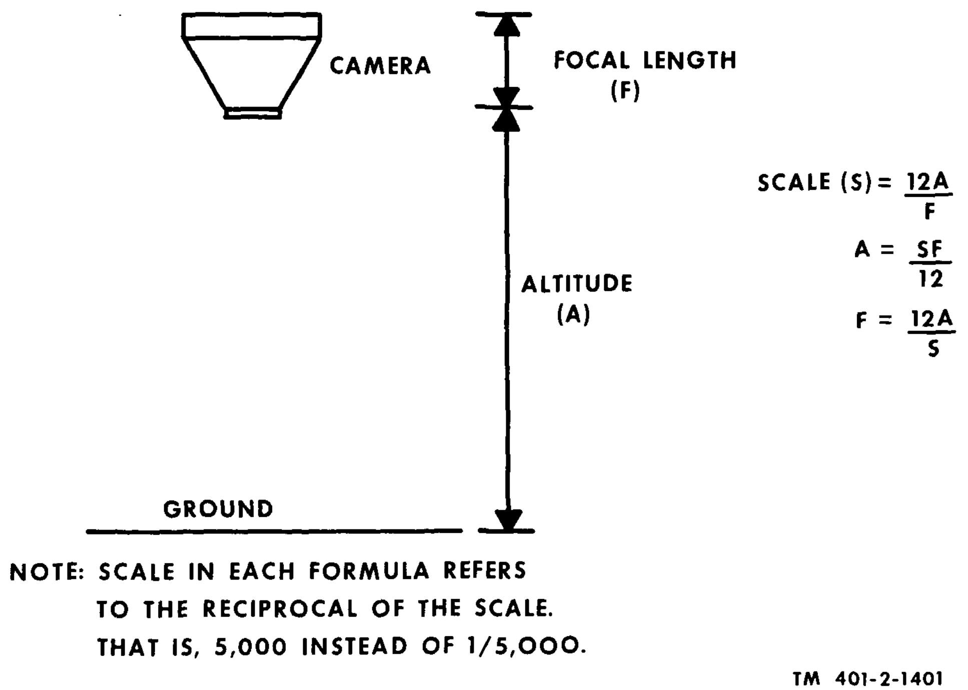

Figure 14-2. Scale, altitude, and focal length.

14-7. Finally, Determine the Flight Plan

a. The last step in planning the aerial photographic mission is to make a detailed flight plan. You can make the initial plan yourself, but sometime before the flight you must get the advice and concurrence of the pilot. The pilot knows the capability of the aircraft, and he may know the target area and the probable flying conditions. For him to fly you to the target, put you in position for the exposures, and return safely, he must know what and how you plan to photograph.

b. You need to use maps in determining the flight plan. Maps and flight plans are discussed in chapter 15, also, the use of maps and how to make the calculations required in planning an aerial photographic flight.

c. How you get to the target area is principally up to the pilot, but you can probably plan on arriving by the most direct route. Mountains, wind conditions, or enemy antiaircraft weapons could make some routes more desirable than others. The pilot is your source of information for the flight out, back, and what to do in an emergency.

d. You may be able to make a preliminary flight over the target area, but plan on starting the photographic run immediately upon arrival at the target area, especially over enemy territory. A practice flight will help assure a successful mission; however, time and other factors seldom permit such luxury. This means you must plan the sequence in which you will make the exposures.

14-8. Plan Sequence of Photographs

a. Plan each exposure so that the flight route is simple and the flight time is kept to a minimum. Even when the enemy is trying to shoot you down, a quick, straight pass over the target is better than a more complex route that will give the enemy more time to hit you. A simple pattern is easier for the pilot to fly, and you'll find it easier for photographing.

b. Do not ask the pilot to make sudden changes in direction, altitude, or speed. Army observation aircraft are highly maneuverable, but even the quickest maneuver takes time and space. While it's not as critical for pinpoint air photographs as it is for stereos, strips, and mosaics; the flight should be as smooth and level as possible during the exposure. You should not make exposures during or immediately after a change in the flight.

c. Pick out landmarks that will aid in flying and photographing. Grid coordinates are ideal for locating points on a map, but you don't see them when looking through your viewfinder.

14–9. How to Plan the Flight Line

The following is the procedure for planning the flight line for a series of exposures:

a. Lay a map of the area flat, and place a tissue or tracing paper over the map.

b. On the paper mark each pinpoint target with a cross (+) or an ×, each strip with a line, and each mosaic by its boundaries.

c. Near each target on the overlay paper, write a brief description of how you will make the exposure. Write for example, "vertical, stereo at 1,200 feet" or "high oblique of south side at 2,000 feet."

d. Draw a line that the aircraft can follow while you make each exposure.

14–10. Summary

Detailed planning is necessary for a successful aerial photographic mission. You should put your plans on paper by answering the following questions. The questions and their answers also summarize this chapter.

	Question	*Where to get the information*
	BASIC INFORMATION	
(1)	How urgent is the need for the pictures?	Requester.
(2)	Where is the target?	Requester.
(3)	What type of a target is to be photographed?	Requester.
(4)	What type and amount of coverage is required?	Requester.
(5)	What is the purpose of the final prints?	Requester.
	FINAL PRODUCT	
(6)	What is the picture content?	Answers to questions (3), (4), and (5).
(7)	What is the scale?	Answers to questions (3), (4), and (5). See also fig. 14–1.
(8)	Will the prints be black and white, color, or infrared?	Answers to questions (4) and (5).
(9)	Will the prints be pinpoints, stereopairs, strips, or mosaics?	Answers to questions (4) and (5).
(10)	Will the views be vertical, high oblique, low oblique, or horizontal?	Answers to questions (4) and (5).
(11)	*How many exposures are required?	Answer to question (4).
	SELECT CAMERA SYSTEM	
(12)	Is a day or night system required?	Answers to questions (3), (4), and (5).
(13)	Should the system be manual, semiautomatic, or automatic?	Answers to questions (1), (9), (10), and (11).
(14)	What specific system will be used?	Answers to questions (12), (13), and whatever systems are available.
	SELECT ASSOCIATED MATERIAL	
(15)	What size, type, and amount of film is required?	Answers to questions (8), (11), and (14).
(16)	What focal length lens will be used?	Answers to questions (7), what are altitude requirements (if any), and what lenses are available. $F=\frac{12A}{S}$ (para 14-5*b*).
(17)	How many flares are required?	Answers to questions (11) and (12).
(18)	What filters will be used?	Answers to questions (8), what altitude, and how much haze is expected (para 14–6*c*).
	MAKE FLIGHT PLAN	
(19)	*What are the targets? (Answer by marking a map.)	Answer to question (2).
(20)	*What types of exposure are required? (Answer by making notes on map near target.)	Answers to questions (9) and (10).
(21)	*What is the flight path? (Answer by drawing lines on the map.)	Answers to questions (19) and (20).

*Chapter 15 covers in detail how to determine the answers to questions (11), (19), (20), and (21).

14–11. Review Problem

a. Answer as many of the questions in the summary (para 14–10) as you can, given the situation below.

b. A garrison review will be held at 1000 hours the day after tomorrow on the parade grounds (area=800 ft x 1,000 ft). The command wants aerial photographs for news, publicity, and historical records. Three views are desired. They should show—

(1) The entire garrison body at attention.

(2) The presentations at the reviewing stand.

(3) The troops passing in review.

c. Now, plan the mission.

14–12. Answer to Review Problem

The answers to some of the questions are limited by the material that is available, involve personal preference, or require information that was not given. Thus, the following is *one* solution to the problem, but it is *not* the *only* possible solution. The statements in (1) through (21) below are answers to questions (1) through (21) in paragraph 14–10.

(1) No unusual urgency. The pictures have to be taken in the morning of the day after tomorrow, and normal processing is sufficient.

(2) The parade grounds.

(3) Large groups of people.

(4) Three scenes: entire garrison (low oblique), presentation (high oblique), and troops passing in review (high oblique). All at low altitude (large scale).

(5) News, publicity, and historical records.

(6) *First scene:* 10 companies in formation on a field 800 ft x 1,000 ft, a vertical and a low oblique view looking into the troops. *Second scene:* review stand, about 100 ft x 50 ft, high oblique looking into the stand. *Third scene:* troops passing in review, high oblique from northwest of review stand.

(7) Not critical. First scene about 1:2,400 (to cover the full field). The others about 1:240 (to show individuals).

(8) Black and white.

(9) Pinpoints.

(10) One vertical, one low oblique, and the others high oblique.

(11) Six, two of each scene.

(12) Day.

(13) Manual.

(14) KS–4A(1).

(15) 4 x 5 sheet, panchromatic, 6 exposures.

(16) 5 inch.

(17) None

(18) None.

(19–21) The answers require a map.

CHAPTER 15

MAPS AND FLIGHT PLANS

Section I. MAPS

15-1. Introduction

On an aerial photographic mission, your flight time over the target is short. Often you have no time for a practice run or a second try. Still, you're expected to bring back excellent pictures—pictures that will fulfill the purpose of the mission. You must have a good plan—a plan that describes the exact course the plane will fly and that tells when and how to make each exposure.

15-2. Materials for Drawing a Flight Plan

To draw a flight plan for an aerial photographic mission you should have a map, pen, straightedge, tracing paper, information about the mission (ch. 14), and a flat surface to work on.

a. The map used for planning should be the same map that you and the pilot will use during the flight. A large-scale map gives greater detail, while a small-scale map covers a larger area. The scale of the map you use should be large enough to clearly define the target and small enough to include a large area surrounding the target. If the target is some distance away, you might need two maps—one for going to and returning from the target area and the other for use over the target area.

b. Use tracing paper over the map to protect it for future missions while providing a map surface on which to write and draw. There are many substitutes you can use for tracing paper. For instance, you can write on clear acetate (plastic) sheets with a china marker (grease pencil). Typewriter tissue is thin enough to easily see through, and if you have a shadow box you can use almost any paper.

c. You need a pen, pencil, or other marking device to write and draw on the overlay paper and a straightedge to draw flight path lines.

d. You will also need the information you developed about the target and exposure (ch. 14).

15-3. Locate Each Target on Your Map

Before drawing flightpath lines and marking the map overlay, become familiar with the map and the area of the mission. Read the marginal data on the map. Take note of any outstanding features such as rivers, roads, lakes, or hills. Use the grid lines on the map to locate and identify the target.

15-4. The Military Grid Reference System

a. The Military Grid Reference System is a combination of two systems—the Mercator and the Polar. The Universal Transverse *Mercator* Grid System (fig. 15-1) covers the earth from the 80th parallel south to the 84th parallel north, while the Universal *Polar* Stereographic Grid System (fig. 15-2) covers the Polar regions south of 80° south and north of 84° north. In these systems the entire world is divided into zones. Each Mercator zone is 6 by 8 degrees, and each Polar area contains two zones. Part A of figure 15-2 shows the North Pole area divided into two grid zones marked Y and Z.

b. Each Mercator zone is identified by a number-letter combination, and each Polar zone by a letter. Florida, for example, is in zone 17R. Each zone, both Mercator and Polar, is divided into 100,000-meter squares that are identified by a double letter combination. Fort Monmouth, New Jersey, for example, is located in zone 18T and in the 100,000-meter square WV (fig. 15-3). Part B of figure 15-2 shows the Polar zones divided into 100,000-meter squares.

c. Each 100,000-meter square is subdivided by numbered grid lines that divide the square into smaller squares. They are 10,000, 1,000, 100, or 10 meters wide depending on the map scale and how accurately points are to be located. Figure 15-4 divides the 100,000-meter square WA into 10,000-meter squares and shows point A located at WA57.

d. Official military maps all use the same grid system, but there are other systems. So you may find that the grid reference of a point may not be identical on different maps of the same area. To locate a point from its grid reference you must have the map using that particular grid system.

15-5. How to Locate a Point

a. You identify a point by stating the vertical and horizontal grid lines that intersect at the point. State both grid line numbers as one number giving the vertical grid line first and the

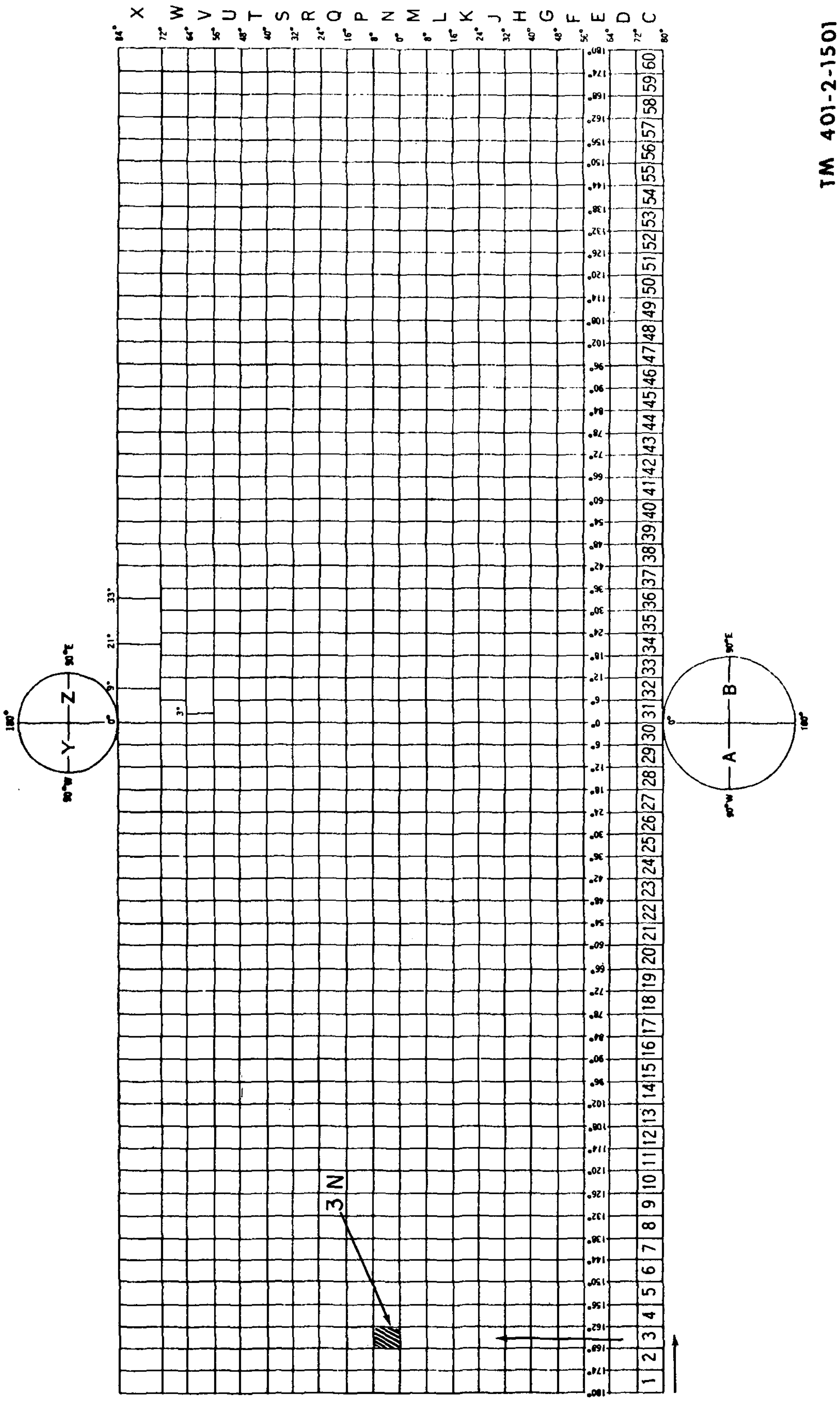

Figure 15–1. The Mercator Grid System.

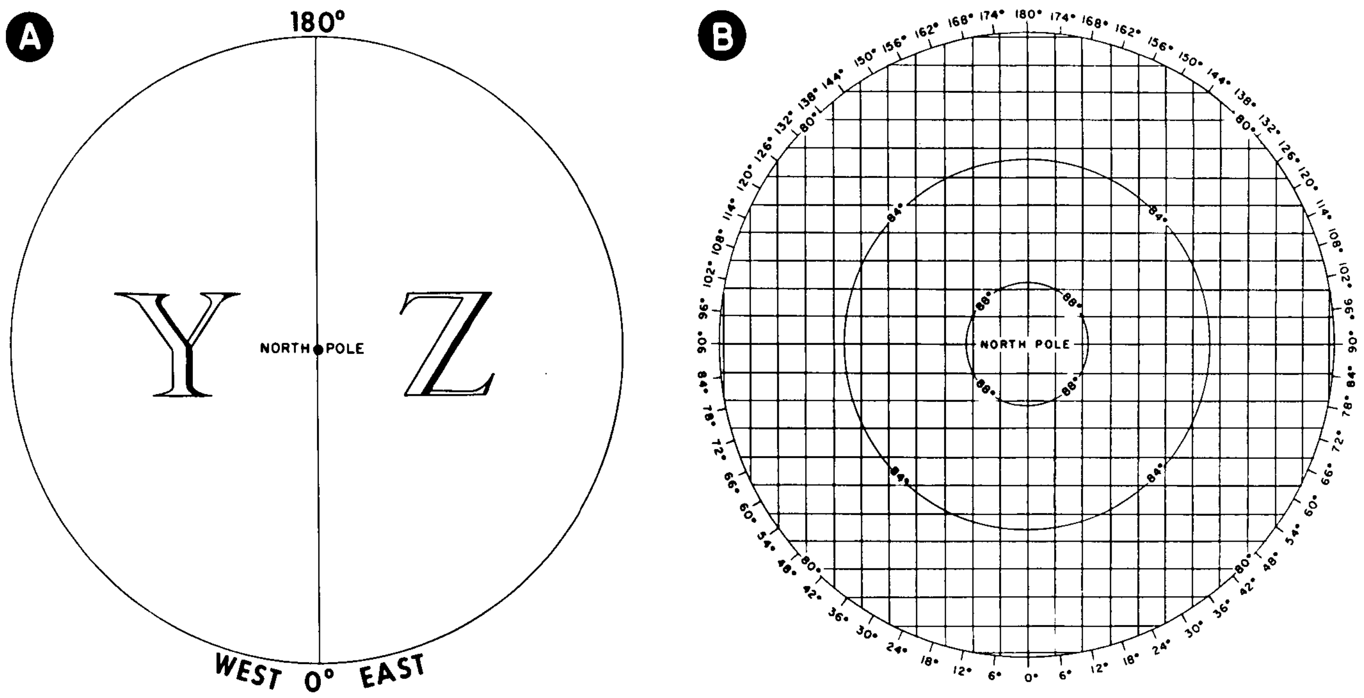

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Figure 15-2. The Polar Grid zones.

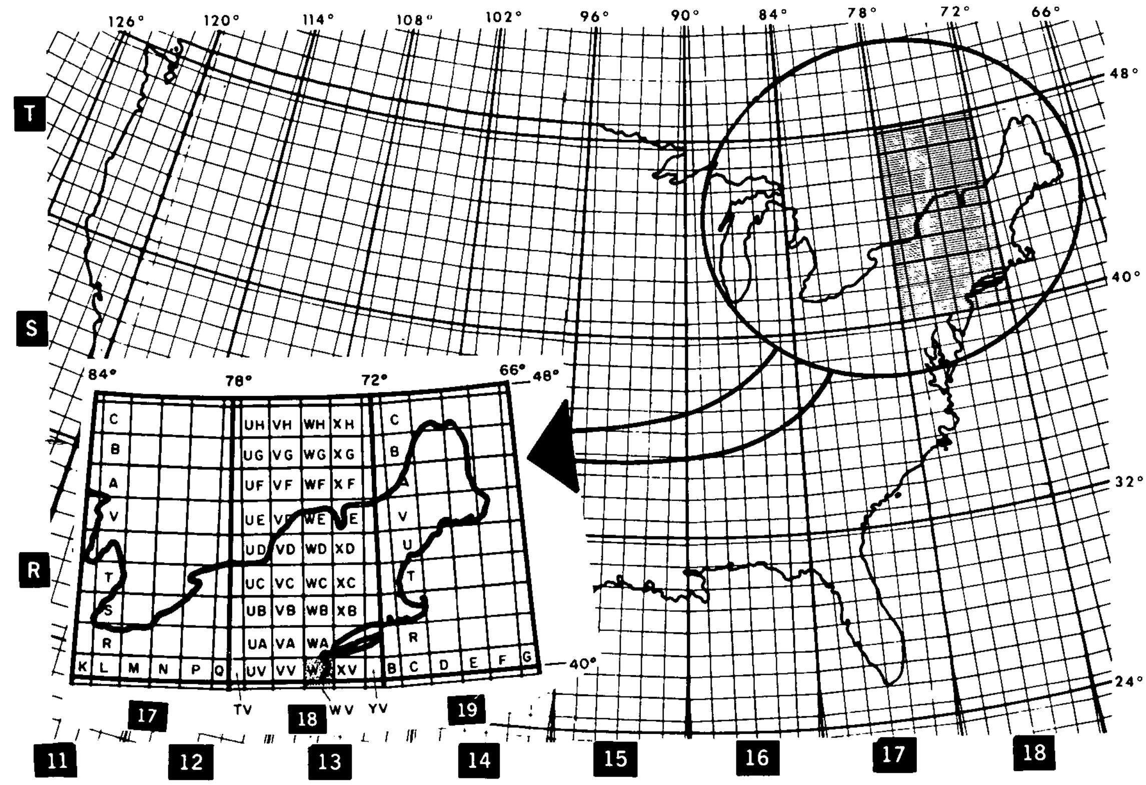

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Figure 15-3. Zone division.

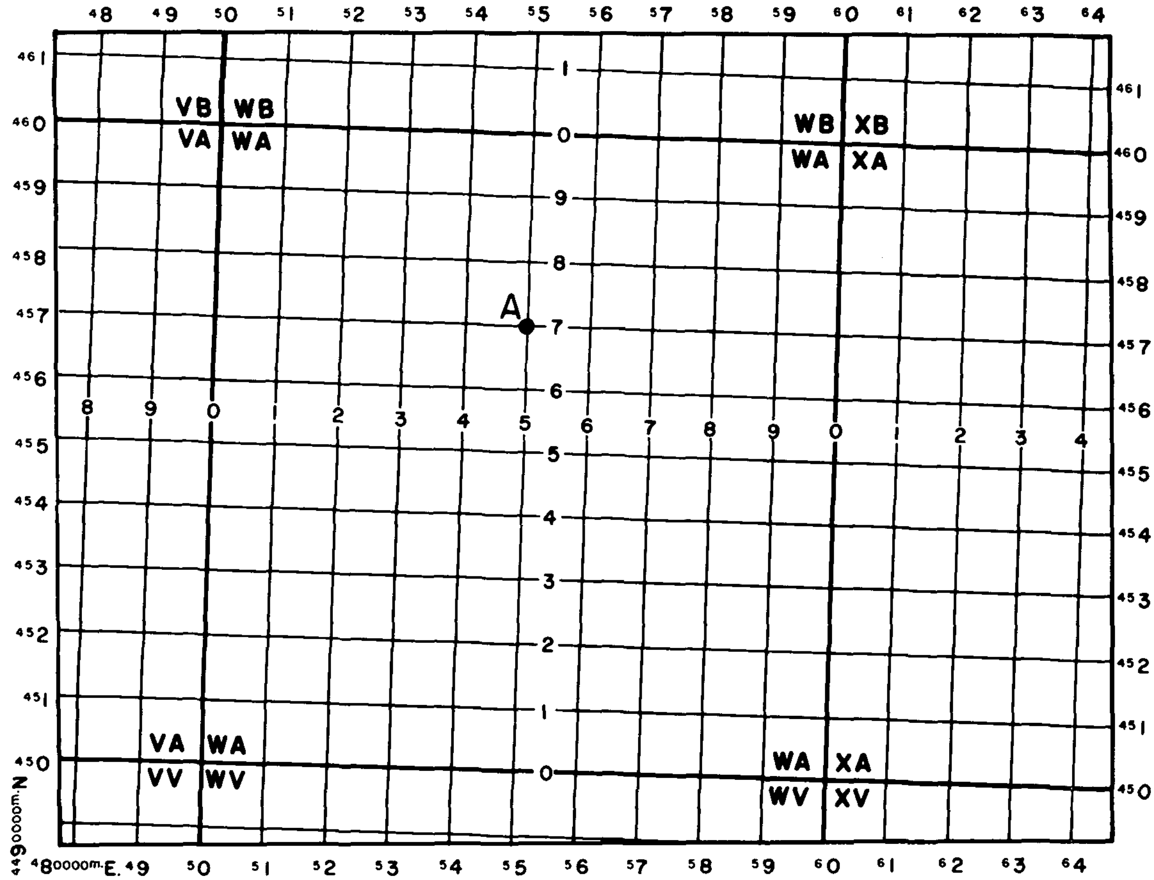

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Figure 15-4. Grid location.

horizontal grid line second with *no* punctuation between. In figure 15-4, point A (grid reference WA57) is located at the intersection of vertical grid line number 5 and horizontal grid line number 7. The grid numbers are actually 55 (vertical) and 457 (horizontal) as shown on the edge of the map, but only the boldface or large print digits are used for the grid reference.

b. When the point does not fall on a grid line, then the decimal distances from the grid lines nearest the left and below are tacked onto the grid numbers, but the decimal point is omitted. In figure 15-5 you can see that Roosevelt School is located at 831502. The first half (831) of the number gives the position of the school as one-tenth the distance between grid lines to the right of vertical line 83. The second half (502) says start at horizontal line 50 and go up two-tenths of the way to grid line 51. In figure 15-5, what is located at grid reference 844518?

c. The answer to the question in *b* above is Ocean Grove Auditorium. Both of the references in *b* contain six digits; all grid references contain an even number (2, 4, 6, or 8) of digits. If one grid line is given to the nearest tenth then the other must also be given to the nearest tenth.

15-6. How to Locate an Area

a. You locate an area by identifying the grid intersection closest to the southwest corner of the area. The grid reference for the town of Ocean Grove (fig. 15-5) is 837510. Thus, Ocean Grove lies east (to the right) of grid line 83.7 and north (above) of grid line 51. Usually you would see the area referenced to whole grid line numbers, and our Ocean Grove example would be 8451 because most of the town lies to the right of line 84 and above line 51. A word description usually accompanies the grid reference to clearly outline the area.

b. Given any grid reference, you should remember that the point or area referenced is either at the intersection of the two grid lines or in the square area just to the right and above the intersection.

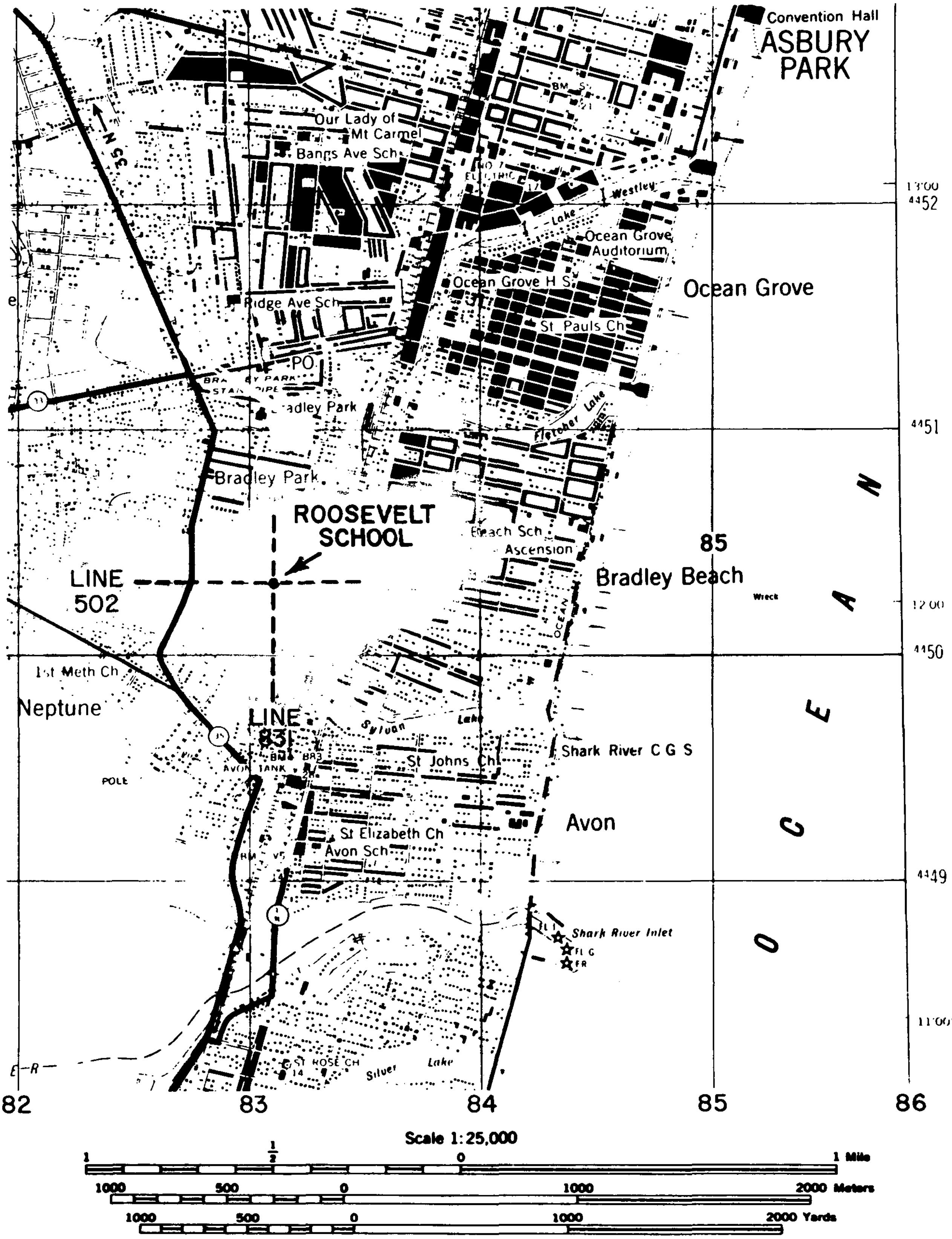

Figure 15-5. Location by grid reference.

15-7. How to Mark Targets on Your Map

Once you have located the target, you should mark it on the map, or map overlay, as follows:

a. Lay the map out on a flat surface. On most maps the top of the map is north, and all the printing is made so that you read from the south side of the map. Reading a map is easier if the top of the map is forward so that the map lies in front of you just as the ground does. Thus, you may find your map easier to use during the flight if you write on it so that the top is in the main direction of your flight.

b. Place tracing paper over the map. Use tape, tacks, or weights to hold the paper in place.

c. Mark and identify two grid intersections so that the tracing paper can be removed and then replaced in the same position. See point A (grid ref. 8249) and point B (grid ref. 8549) on figure 15-6.

d. Mark pinpoint targets with a cross or an X, mark strips with a line, and trace the boundary of an area target. In figure 15-6 point C (grid ref. 832491) is a pinpoint target. The section of Route 35 between the cross lines (828511) and 829496) is a long narrow target (D). Note how you indicate the ends of a long narrow target by short cross lines. The area inside the boundary lines (E) is a large, area target.

e. Near the target show the type of photograph and any other information that will aid your planning or photographing, such as picture type, altitude, scale, and angle (fig. 15-6).

f. Mark the direction of north.

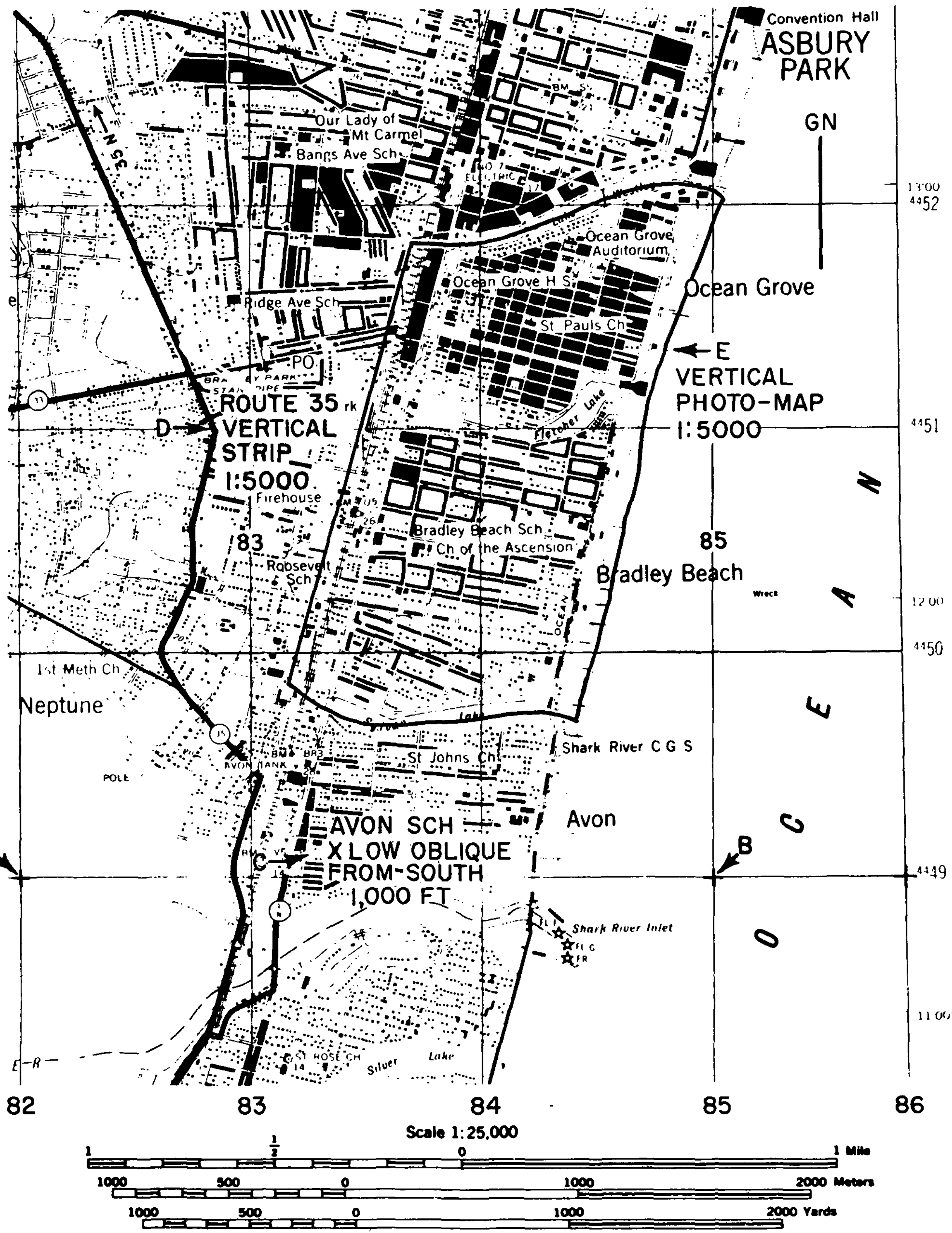

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Figure 15-6. Marking targets.

Section II. DRAWING FLIGHTPATHS

15-8. How to Draw A Flightpath for Pinpoints

After you have marked all of the targets on the map, you can draw a line that shows the path the aircraft will fly. The following are rules to remember when you draw a flightpath for pinpoint aerial photographs and stereo pictures:

a. Keep the path simple. Use straight lines when possible, because the aircraft must be flying straight and level just before and during an exposure. Do not make sharp turns; allow space for the aircraft to make a turn, and avoid sudden changes in altitude.

b. The path goes directly over the target for a vertical aerial air picture.

c. The path goes to one side of the target for obliques and horizontals. The more oblique the picture, the farther you must fly to one side of the target. The distance between the flightpath and the target increases with altitude. For most obliques you don't need accurate measurements, so all you have to remember is that a greater distance is required for a higher altitude or a higher oblique (fig. 15-7). Table 15-I gives some typical values of the distance between the flightpath and the target. By using trigonometry (beyond the scope of this manual), you can make precise calculations.

Table 15-I. Ground Distance From Target

Altitude (ft)	Distance (ft) for low oblique (30°)	Distance (ft) for high oblique (60°)
100	58	173
200	116	346
500	289	866
1,000	577	1,732
2,000	1,155	3,464
5,000	2,887	8,660

d. Marking. Along the flightpath on your overlay, mark the altitude, azimuth (direction), groundspeed, and landmarks.

15-9. A Flightpath for Pinpoints

a. Assume that your mission is to photograph the following three targets in figure 15-8 at an altitude of 1,000 feet: a low oblique of Bradley Park School (grid ref. 831511) from the east,

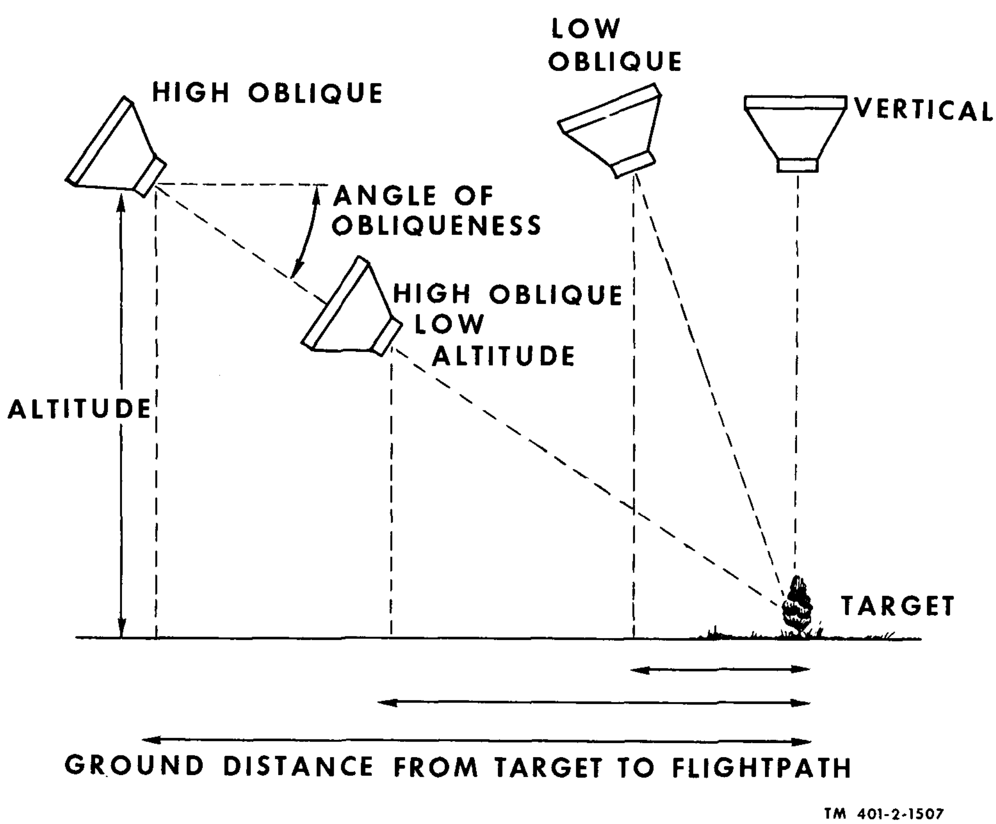

Figure 15-7. Distance between flightpath and target.

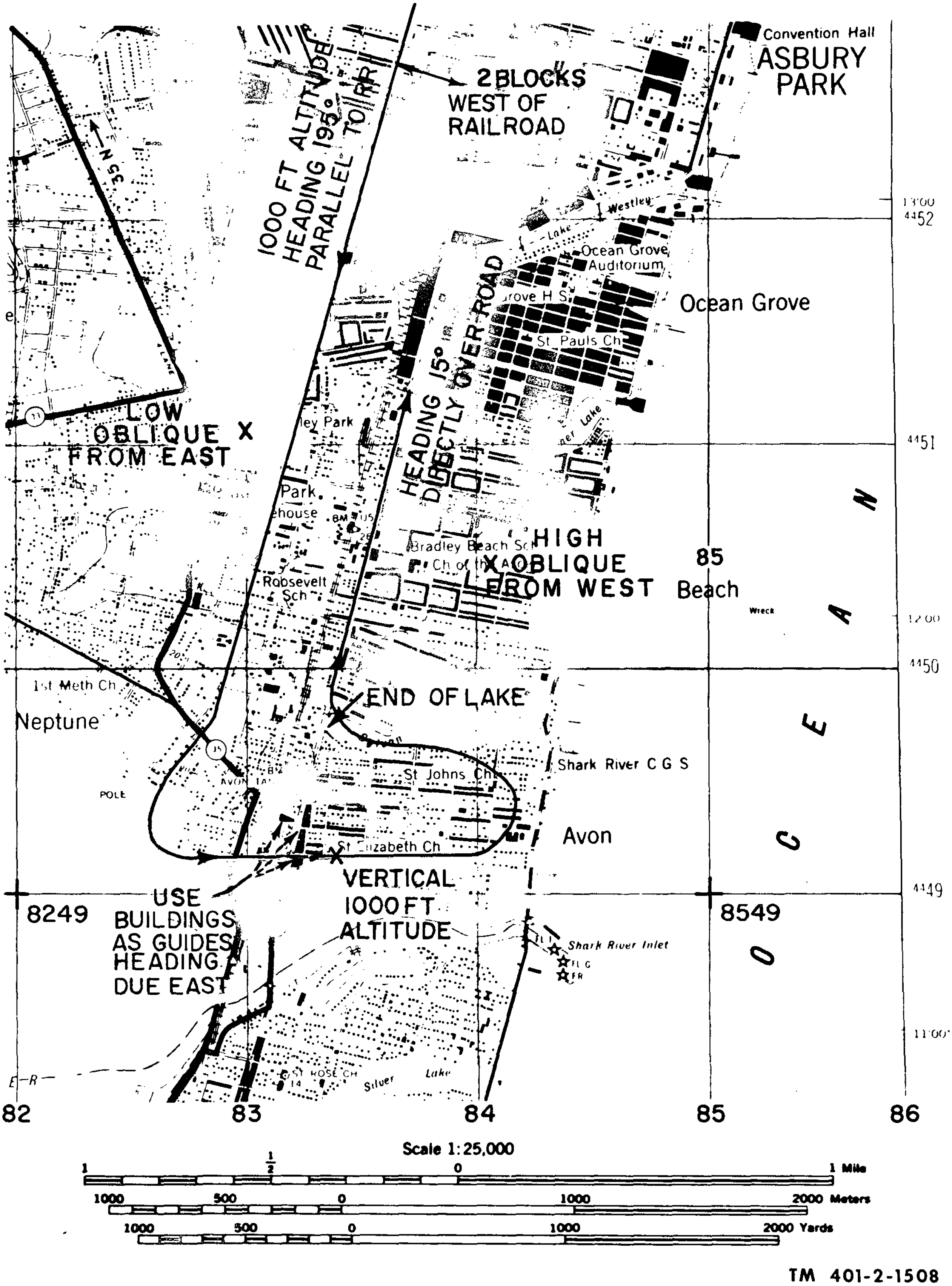

Figure 15–8. Flightpath for pinpoint air photographs.

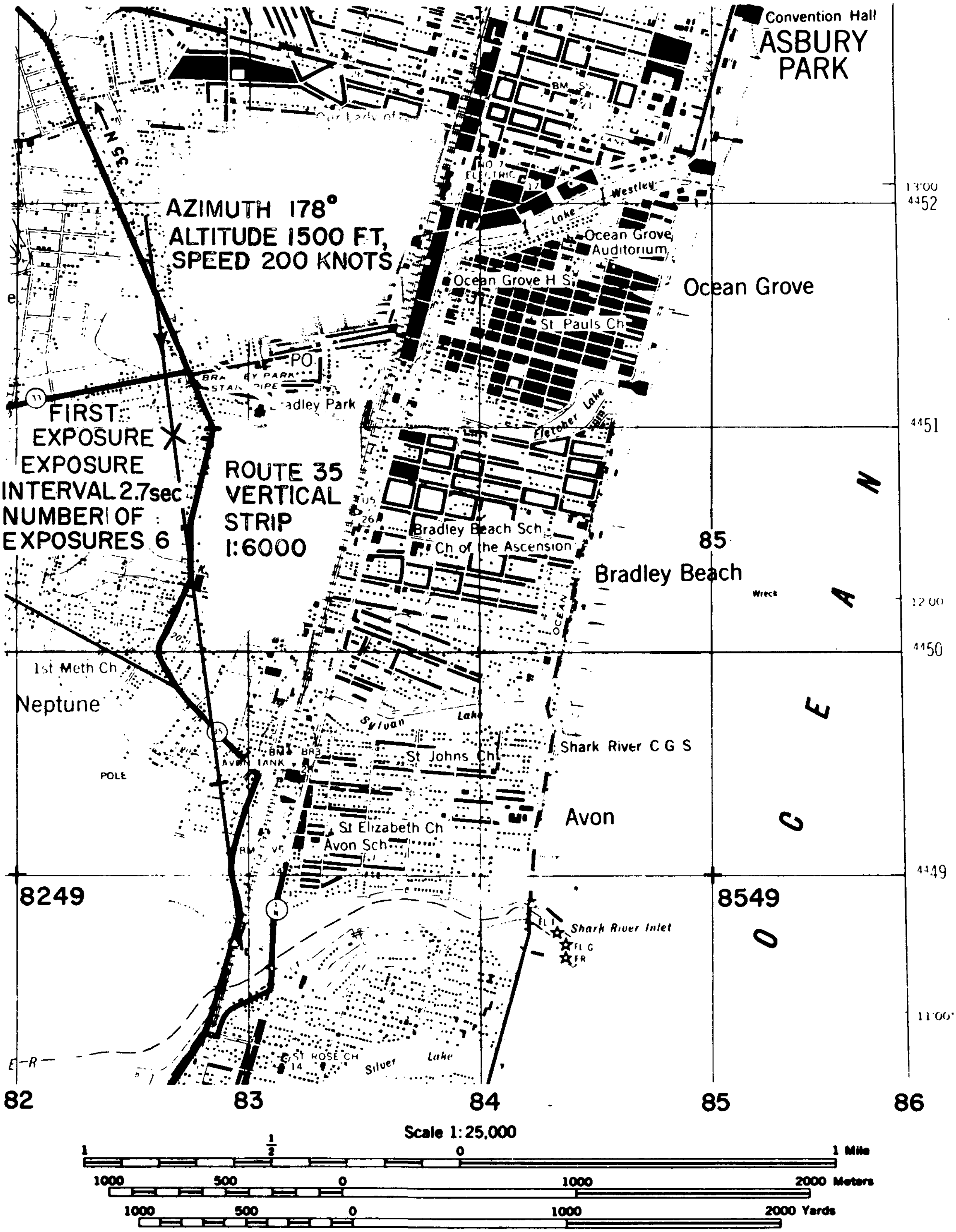

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Figure 15-9. Example of flightpath for a strip.

a vertical of Avon School (grid ref. 832491), and a high oblique of Bradley Beach School (grid ref. 837504) from the west. Assuming that we are approaching the target area from the north, figure 15-8 shows a possible flightpath.

b. In figure 15-8, note that the flightpath does not go directly over the two targets that are to be photographed obliquely, but does pass over the vertical target. The flight is along obvious ground features—the railroad, buildings, lake, etc. The speed of the aircraft is not an important factor because the photographs do not overlap, and at 100 knots the targets are about 80 seconds apart.

15-10. How to Draw a Flightpath for a Strip

a. General. When you draw a flightpath for a strip (fig. 15-9), perform the actions in *b* below. Also, use the rules for pinpoint aerial photographs as a guide.

b. Actions Required. In the following chart, the actions in the first column are explained, as required, in the second column. The third column is an example of the action.

Action	Explanation	Example
1 Mark the target	Mark on the map. See para 15-7	See fig. 15-9.
2 Draw a flight line	A straight line through the center of the target	See fig. 15-9.
3 Mark the ends of the target on the flight line		See fig. 15-9.
4 Measure the length of the target	Use the bar scale on the map	4,260 ft.
5 Measure the width of the target	Use the bar scale on the map	1,650 ft.
6 State the scale	The scale of the photograph	1:3,000.
7 State the focal length of the lens		6 in.
8 Compute the altitude	Divide the focal length (item 7) by the scale (item 6). Then divide by 12 to convert inches to feet.	6/(1/3000) =18,000 in. or 1,500 ft.
9 State negative size		9 in. by 9 in.
10 Compute ground coverage of the negative	Divide the negative size (item 9) by the scale (item 6).	9/(1/3000) =27,000 in. or 2,250 ft.
11 Is the film format wide enough to cover target?	Compare items 5 and 10	Yes.
12 State the percent of forward overlap		60%.
13 Compute ground gain forward (GGF)	Multiply the forward ground coverage (item 10) by the percent not overlapped (1 minus item 12).	2,250 x (1-0.60) =900 ft.
14 Compute the number of exposures	Divide the target length (item 4) by the GGF (item 13); then add 2.	(4260/900)+2=6 exposures.
15 State the knots made good (KMG)	This is the groundspeed of the aircraft	200 knots.
16 Compute the exposure interval	Multiply the GGF (item 13) by 0.592 and then divide by the KMG (item 15).	900 x 0.592/200 =2.7 seconds.
17 On the map mark the direction of the flight line, the center of the first exposure, the altitude, the groundspeed, the number of exposures, and the exposure interval.	See items 2, 3, 8, 14, 15, and 16	See fig. 15-9.

15-11. How to Draw A Flightpath for a Mosaic

a. General. The flightpath for a mosaic is a number of parallel flight lines. Figure 15-10 is an example. Draw each line as you would draw a flight line for a strip photograph.

b. Required Actions. The procedure in the following chart for drawing flight lines for a mosaic is a modification of the procedure for drawing strip flight lines (para 15-10):

Action	Explanation	Example
1 Outline the target area		See fig. 15-10.
2 Square the target area	Draw a rectangle that will just include the target area.	See fig. 15-10.
3 Measure target area: *a*. Length. *b*. Width.	Use the bar scale on the map to determine the dimensions of the rectangle.	2,900 yd. or 8,700 ft. 1,500 yd. or 4,500 ft.
4 State the scales: *a*. Photographic *b*. Map		 1:3,000. 1:25,000.
5 State the focal length of the lens		6 in.
6 Compute the altitude	Divide the focal length (item 5) by the photographic scale (item 4*a*).	6/(1/3000) = 6 x 3,000 = 18,000 in. or 1,500 ft.
7 State the negative size: *a*. Forward *b*. Sideward		 9 in. 9 in.
8 Compute the ground coverage of negative: *a*. Forward *b*. Sideward	 Divide negative size (item 7*a*) by the photographic scale (item 4*a*). Divide negative size (item 7*b*) by the photographic scale (item 4*a*).	 9/(1/3000) = 9 x 3,000 = 27,000 in. or 2,250 ft. 9/(1/3000) = 9 x 3,000 = 27,000 in. or 2,250 ft.
9 State percent overlap: *a*. Forward *b*. Sideward		 60%. 40%.
10 Compute ground gain: *a*. Forward *b*. Sideward	 Multiply ground coverage (item 8*a*) by percent not overlapped (1 minus item 9*a*). Multiply ground coverage (item 8*b*) by percent not overlapped (1 minus item 9*b*).	 2,250 x (1-0.60) = 900 ft. 2,250 x (1-0.40) = 1,350 ft.
11 Compute number of runs	Add 1 to width of target area (item 3*b*) divided by the GGS (item 10*b*).	4,500/1,350+1 = 3.3+ 1 = 4 runs.
12 Compute exposures: *a*. Per run *b*. Total	 Add 2 to length of target area (item 3*a*) divided by GGF (item 10*a*). Multiply exposures per run (item 12*a*) by the number of runs (item 11).	 (8700/900)+2 = 9.7+ 2 = 12 exposures per run. 12 x 4 = 48 exposures.
13 State knots made good (KMG)	This is the groundspeed of the aircraft	200 knots.
14 Compute the exposure interval	Multiply the GGF (item 10*a*) by 0.592 and then divide by the KMG (item 13).	900 x 0.592/200 = 2.7 seconds.
15 Compute the distance between flight lines	Multiply the GGS (item 10*b*) by the map scale (item 4*b*).	1,350 (ft) x 1/25,000 = 16,200 (in.)/25,000 = 0.65 in.
16 Draw the first flight line	Directly over one of the long edges of the rectangle	See fig. 15-10.
17 Draw the other flight lines	All flight lines are parallel to each other and are separated by the GGS (item 10*b*). For the map distance use the result of item 15 or the bar scale.	See fig. 15-10.
18 On the map mark the direction of each run and label the first, the center of the first exposure in each run, the altitude, the ground speed, the number of exposures per run, the total number of exposures, and the exposure interval.	See items 6, 12, 13, 14, and 16	See fig. 15-10.

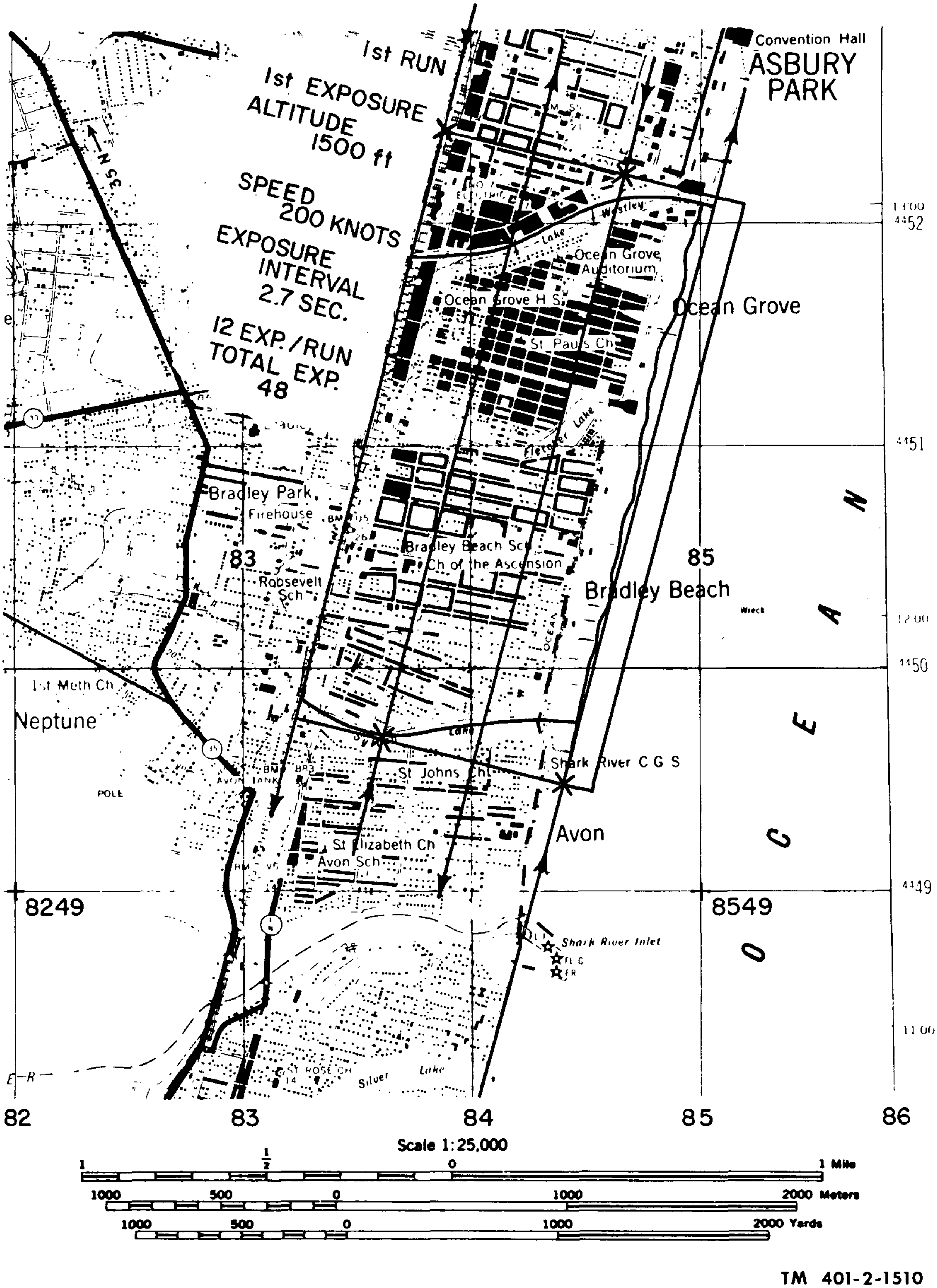


Figure 15-10. Flightpath for a mosaic.

15–12. Oblique Strips and Mosaics

Oblique strips and mosaics are not very common. You can use the procedures for vertical strips and mosaics (paras 15–10 and 15–11) as general guides for oblique strips. In addition, the following information also applies:

a. Overlapping oblique exposures do not match together as well as verticals.

b. The flight line for an oblique does not pass directly over the target. The ground distance between the target and the flight line increases with obliqueness and with altitude.

c. The scale on an oblique is not constant. It decreases continuously in the ground direction that the camera is pointed. Because the scale depends on the camera-to-subject distance rather than altitude, it decreases as the camera angle becomes more oblique.

d. The individual strips of an oblique mosaic will match together better if you use the same flight line and increase the obliqueness on each succeeding strip.

e. Greater overlap provides better matching.

Section III. SUMMARY AND PROBLEM

15–13. Summary

a. Before the flight you should carefully plan the sequence of exposures and the exact course the aircraft will fly over the target.

b. In planning a flight, it is preferable to use the same map that you will use during the flight.

c. Before drawing a flightpath, locate and mark the targets on the map.

d. The Mercator Grid Reference System for identifying locations is the common system used on military maps.

e. You identify a point location by stating the vertical and horizontal grid lines that intersect at the point.

f. You identify an area location by stating the vertical and horizontal grid lines that intersect at the southwest corner of the area.

g. Mark pinpoint targets with a cross, and trace the boundary of an area target. Near the target state the type of photograph you'll take and other pertinent data.

h. Draw a path that the aircraft can follow while you do the photographing.

i. The flightpath should be a simple one with no tricky maneuvers.

j. For strips and mosaics determine the exposure interval and the number of exposures.

k. Note landmarks that will aid in flying the path.

15–14. A Practice Problem

Try your hand at preparing a flight plan using the map in figure 15–11 and the following information. The solution is in paragraph 15–15.

a. Type of photograph: vertical mosaic, scale 1:5,000.

b. Target: Pemberton International Airfield (grid ref. 2623) to include Pemberton-Wrightstown road to the east, grid line 23 to the south, first road to the west (the one shaped like a curved ball), and North Branch Rancoss Creek to the north.

c. Camera: KA-30 (a 6-inch lens with a negative size of 4.5 x 4.5 inches).

d. Aircraft speed: 200 knots (no wind).

e. Use standard overlap.

15–15. Solution to Practice Problem

You can solve the problem by performing each action listed in the chart in paragraph 15–11. Here is the result.

Item	*Answer*
1	See figure 15–12.
2	See figure 15–12.
3*a*	2,400 yd. (7,200 ft).
b	1,400 yd. (4,200 ft).
4*a*	1:5,000.
b	1:25,000.
5	6 in.
6	30,000 in. (2,500 ft).
7*a*	4.5 in.
b	4.5 in.
8*a*	22,500 in. (1,875 ft).
b	22,500 in. (1,875 ft).
9*a*	60%.
b	40%.
10*a*	750 ft.
b	1,125 ft.
11	3.7+1=5 runs.
12*a*	9.6+2=12 exposures/run.
b	60 exposures.
13	200 knots.
14	2.22 sec.
15	0.54 in.
16	See figure 15–12.
17	See figure 15–12.

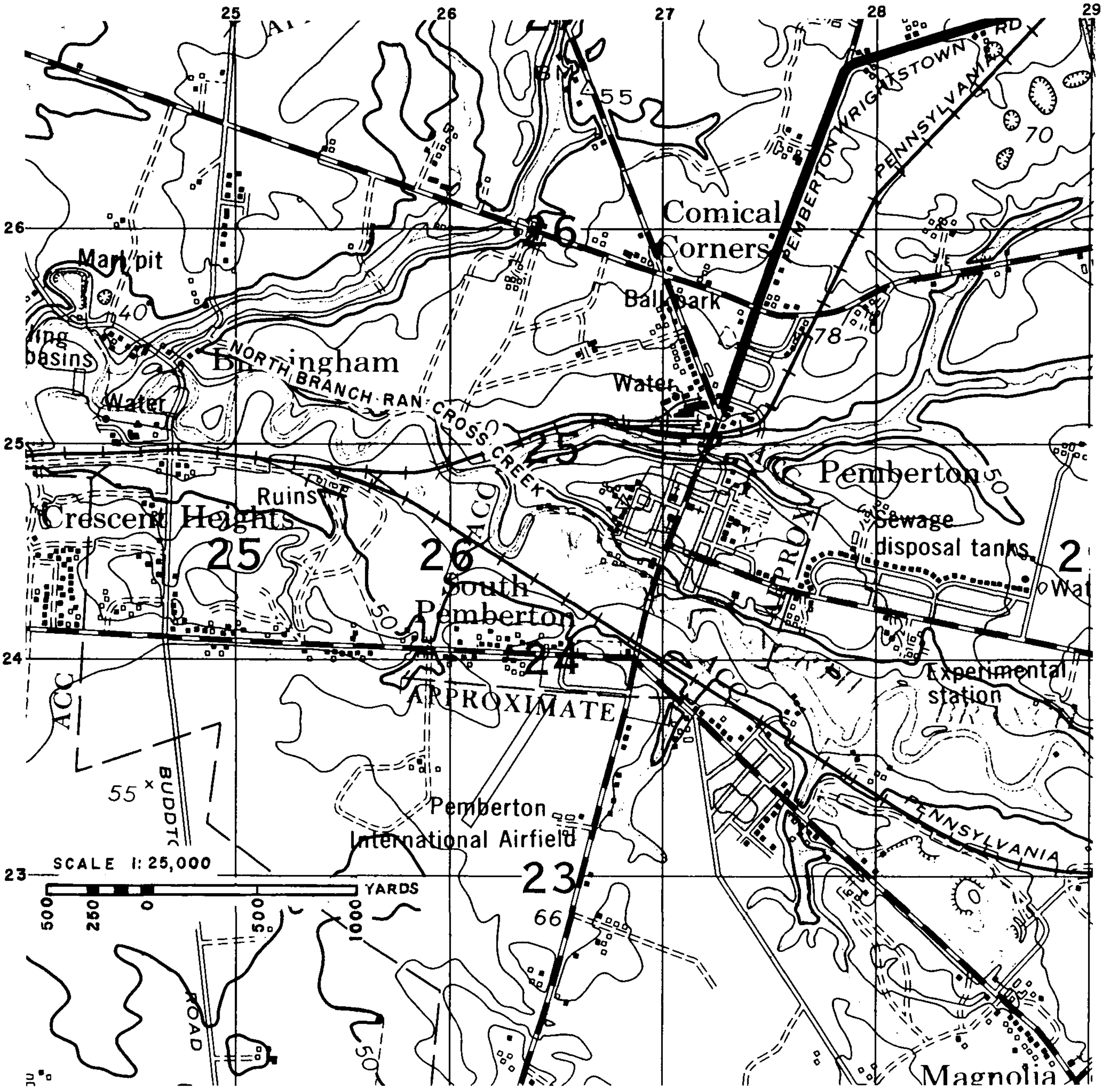


Figure 15-11. Map for problem.

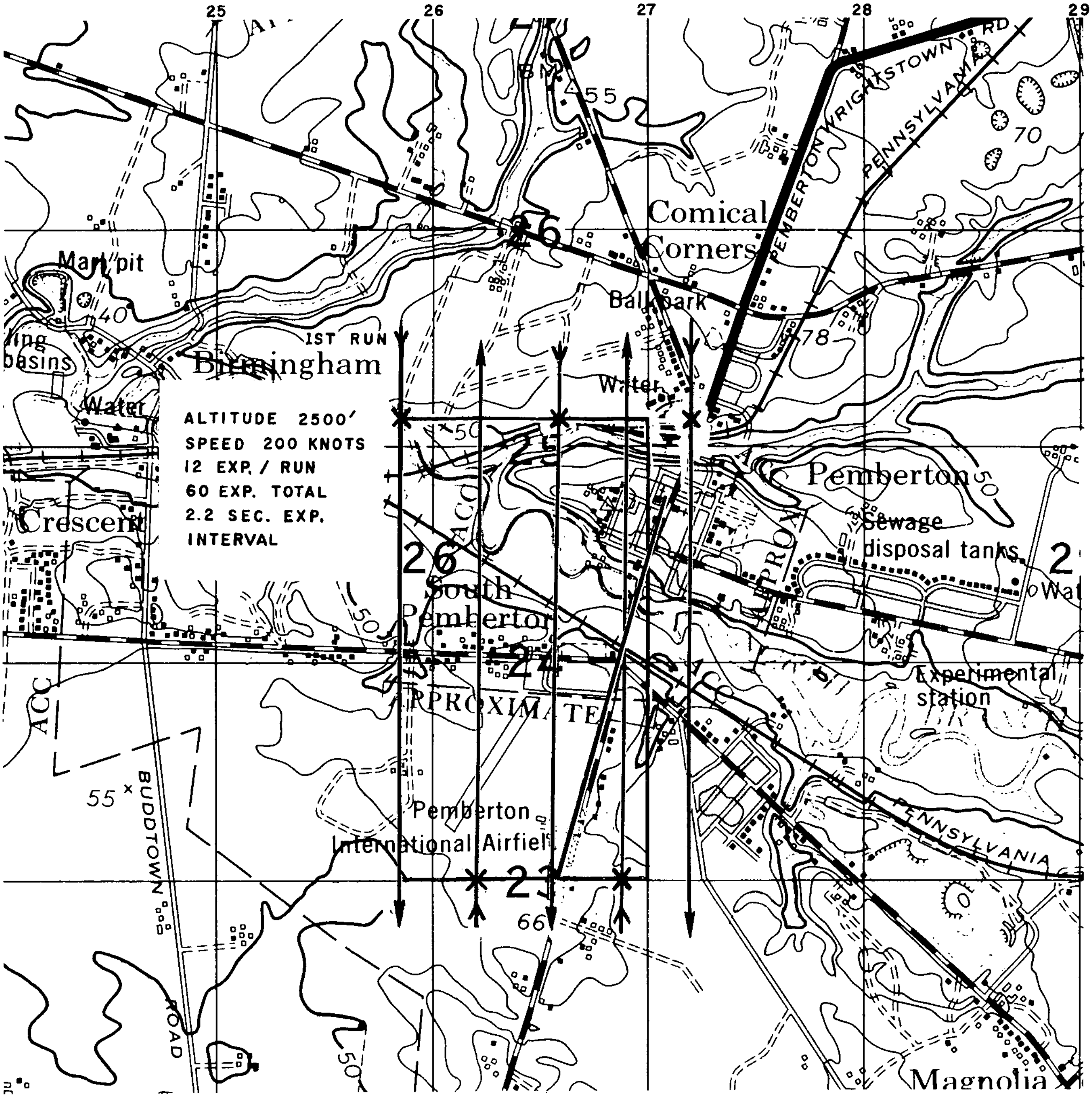


Figure 15–12. Problem solution.

CHAPTER 16

THE AERIAL MISSION

16–1. Introduction

An aerial photographic mission involves careful planning, preparation, photographing, recordkeeping, and coordination between the pilot and the photographer. Planning an aerial photographic mission was discussed in chapters 14 and 15. Preparation, photographing, recordkeeping and coordination is discussed in this chapter.

a. Planning starts with a request for photographs and includes determining the type of photographs, number of pictures, type of camera system, type of film, camera accessories, sequence of exposures, flight time, and flightpath.

b. Preparation includes making flight arrangements, getting the necessary material, and checking out the equipment.

c. Photographing is the action you take over the target area.

d. Recordkeeping means preparing an accurate written account of the what, where, when, and how of the mission.

e. Coordination means that you and the pilot work as a team.

16–2. Pilot and Photographer—A Team

a. The pilot's main responsibility is to get the photographer and the photographic equipment to the target, in position for photographing, and back home safely. The pilot knows what his aircraft can and cannot do. He knows the best route to fly and what to do in an emergency. Ask him about the route and emergency plans and take his advice.

b. Because the pilot must place the photographer in position to take the picture, he must know the details of the mission. Explain to him the type of exposures you want and how you expect to do the photographing. When photographing on the ground you can move either the object or yourself to get the proper composition for your picture, but in the air you must rely on the pilot to obtain the desired camera angle and the correct camera-to-subject distance. He cannot read your mind, and there is too much to do during the mission for you to explain then, so discuss your plans before the flight.

c. Other reasons for discussing plans before the flight are that you may have included something the aircraft is incapable of, or the pilot may see an easier maneuver to obtain the same results.

d. The noise level during the flight may be high and voice communications are not always at their best in surveillance aircraft, especially in helicopters. Establishing a few hand signals beforehand with the pilot may prove very helpful during the mission—hand signals that indicate "there's the target"; "move right, left, up, down"; "turn right, left"; and "steady, I'm photographing."

e. On the ground the photographer has sole control over the camera. In the air the camera is, so to speak, in the hands of both the photographer and the pilot. Both must work together.

16–3. Getting Ready for the Flight

To get ready for the flight, you must make arrangements for the flight, discuss the flight plan with the pilot, and prepare and check the camera system.

a. Arrangements have to be made for the flight. You cannot just get into an aircraft and fly away. The flight must be scheduled and cleared, the aircraft prepared, and many people (mechanics, flight directors, etc.) informed; the exact procedure varies. You may not be directly responsible, but you should see that arrangements are made.

b. Discuss the flight details with the pilot and include in the discussion speed, altitude, and maneuvering capabilities of the aircraft, the purpose of the mission, the flight plan and photographic procedures, and emergency plans.

c. Prepare and check the camera system by answering the following questions: Is the camera system complete and in working order? Does the camera have the correct lens, filter, and film? Are all the camera adjustments (shutter speed, f/stop, etc.) set properly? You should have a checklist for the system you are using so that you can quickly and systematically make a final check of the camera system just before the flight. An early check may save you from last minute embarrassment.

16–4. Get Set While Approaching the Target

As you get near the target area get set to work.

a. Recheck the camera system. It should be set and ready for the first exposure.

b. Check the altitude, speed, and direction of the aircraft. Determine if there are any maneuvers that you will have to make for the first exposure.

c. Review your plan. Go over the sequence of exposures, adjustments you have to make between exposures, methods you will use for each exposure, and landmarks or guides for timing exposures.

d. Be on the lookout for the target or landmarks.

e. Get yourself in position. When the camera is mounted on the aircraft, you may have to adjust your position so that you can correctly and comfortably use the viewfinder as well as the operating controls of the camera system. With a hand-held camera you may have to turn around or adjust your position in some way to properly aim the camera.

16–5. Extra Care Required for Hand-Held Cameras

a. When the camera is mounted on the aircraft, the pilot helps to keep the camera steady by flying smoothly along the flightpath, but with hand-held cameras both the pilot and the photographer are needed to keep the camera steady. The pilot keeps the plane moving smoothly, while the photographer holds the camera. Two methods for you to steady the camera are—

(1) Keep your arms close to your body, not tense but firm.

(2) Avoid making contact with the aircraft from the waist up. The whole aircraft shakes from engine vibration so use as much of your body as possible as a shock absorber.

b. With a hand-held camera you have a wide freedom of movement, but the camera's view is limited by the structure of the aircraft. Do not include a wingtip or any other part of the aircraft in your pictures, unless you do it intentionally. The best views of the target generally are when the aircraft is approaching or leaving the target and the target is off to one side, as shown in figure 16–1.

c. The wind outside an aircraft can be very strong, so when photographing through an open window do not lean outside unless the loose or flexible parts of the camera are well protected and secured. Get a good grip on the camera, and shield the bellows of a folding camera.

d. Use both hands to hold and operate the camera. The pilot will help you keep a record of the exposures so that you can keep both hands on the camera.

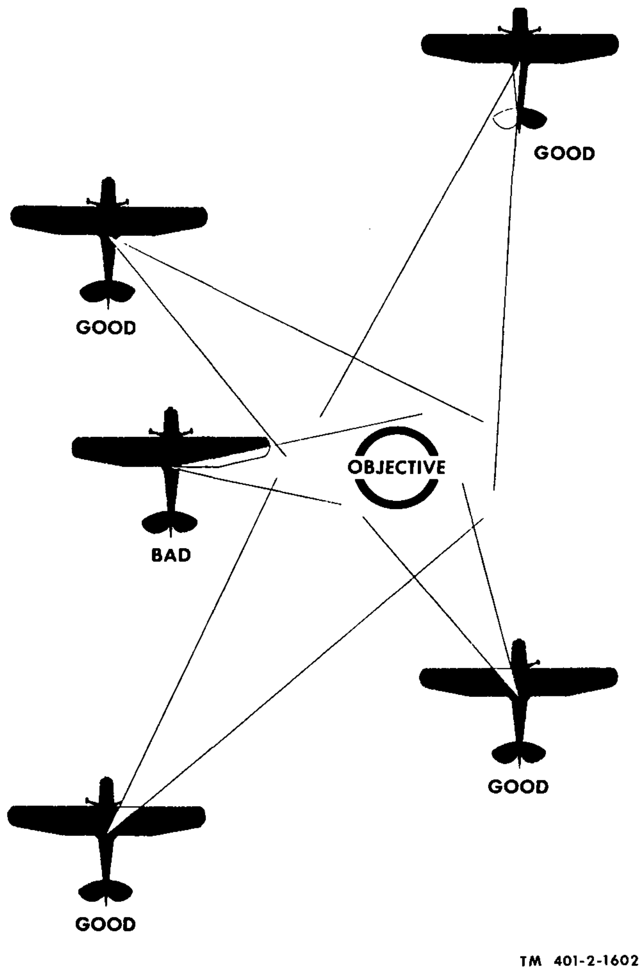


Figure 16–1. Good views.

16–6. Be Observant During the Flight

a. You have planned the mission; it's a good plan, so photograph it exactly as you outlined it, but do not be blind to something significant that might not be in your plan. An unplanned picture might turn out to be the most important or best exposure. This is especially true in a reconnaissance mission where the unit requesting the photographs might not know exactly what it is looking for; it just wants to gather facts about some particular enemy operation. What is happening outside the planned target area could be equally as important as the planned target. Even if you do not photograph any more than is planned, you should make note of any outstanding or unusual ground features and activities.

b. The view from the air is, at times, different from what you imagined when you were planning the mission. If you are observant, you might see a better camera angle, one that will more clearly satisfy the purpose for photographing the target.

16–7. Work on Report During Return Flight

a. On the return flight (or as soon as possible), begin completing a report on the mission. Do it while the mission is still fresh in your mind. Scribbled notes, hastily made between exposures, lose their meaning with time. Make sure that your record of exposures is complete and readable.

b. Make a record of anything you observed that was out of the ordinary, including that which was not photographed or not photographic. You might have an excellent memory, but a written statement is more reliable as a permanent record than the best of memories. Use short, clear, direct, complete sentences.

16–8. After the Flight

a. After the flight, compare your record of the actual results of the mission with your original plans and the request for photographs. You should be ready to explain any differences to the requester. If something was omitted or changed, you might be asked to state why.

b. Finish the report that will accompany the film. If there is anything unusual about either the pictures or the processing, your report should include statements that will help explain the unusual circumstance and aid in processing the film.

c. As soon as possible after the flight, check the camera system to assure that all was working properly during the mission. With most aerial systems the camera is removed from the aircraft between flights.

d. Remove the film from the camera and process it as soon as possible after the flight. With the cameras that use roll film, you should advance the film several frames. Remove it from the camera in a darkroom so that the exposed part of the film is not fogged and that any unused part of the roll can be used on another mission.

16–9. Summary

a. In an aerial photographic mission the pilot and the photographer must work as a team.

b. Before the flight, plan the operation, make flight arrangements, and prepare the camera system.

c. As you approach the target, recheck the camera system, review your plan of operation, and get yourself into position.

d. When taking aerial photographs with hand-held cameras, keep your arms close to your body. Avoid making contact with the plane from the waist up, do not include parts of the aircraft in your pictures, and protect the camera from strong air currents outside the aircraft.

e. Be observant during the flight for anything significant that might add to your information.

f. Prepare a written report to accompany the film.

g. Start film processing immediately after the flight.

16–10. Review Questions

a. Why are hand signals sometimes necessary in aerial photographic missions?

b. What are two methods of steadying hand-held aerial cameras?

c. In what directions (from the aircraft) should you usually photograph with a hand-held camera?

d. When do you write your report on your mission?

16–11. Answers to Review Questions

a. Because of the high noise level.

b. (1) Keep arms close to the body.

(2) Do not touch the aircraft.

c. Either forward and to one side or to the rear and to one side.

d. Start it just before the flight, work on it during the flight, and complete it as soon as possible after the flight.

CHAPTER 17

MANUAL AERIAL CAMERA SYSTEMS

17-1. Introduction

This chapter covers manual Still Picture Cameras KE-15(1), KE-4(1), and KE-12(2), and semiautomatic Still Picture Cameras KA-7(1) and KA-24A. We will discuss their usefulness as aerial cameras, their technical characteristics, and their operation. Automatic cameras are covered in chapter 18.

17-2. General Description of KE-15(1)

a. Still Picture Camera KE-15(1) (fig. 17-1) is part of the Still Picture Camera Set KS-15(1). This is a set of 35-mm photographic equipment used primarily where lens speed, depth of field, and operating ease are most important. The KE-15(1) is not strictly an aerial camera, but because of its lightweight and operational flexibility, you can accomplish a wide range of high quality photography. This set is recommended for aerial missions that include many pinpoint or odd-angle pictures, especially when the exact composition has to be decided on the spot.

b. The set includes the camera shown in figure 17-1, three interchangeable lenses, a universal viewfinder, and other related items.

17-3. Technical Characteristics of KS-15(1)

a. Film. For aerial photography, use a medium speed, commercial 35-mm film. This film has high resolving power and will yield 1- by 1½-inch negatives. Magazines have a film capacity of 20 or 36 exposures.

b. Lenses. The KS-15(1) is equipped with three interchangeable lenses with focal lengths of 35 mm, 50 mm, and 135 mm. All three are of high optical quality and are well suited for aerial photography; however, pinpoint air photographs are best made with the 135-mm lens. This lens limits the subject area coverage and brings out details. It is preferable to record the subject on several negatives, which can be combined later, rather than attempt complete coverage on a single exposure with the wide-angle lens. The 50-mm and 135-mm lenses are marked with an R for focusing in infrared photography. Lens shades for each lens are included in the set.

c. Shutter. The focal plane shutter has a range from 1 to 1/1,000 second. When you use the 135-mm lens, select the fastest possible shutter speed that the light conditions will permit. This will minimize the effects of groundspeed and aircraft vibrations.

d. Filter. An orange (G) filter is included in the set. The filter is made of optically perfect glass, with the color actually in the glass rather than being a sandwiched gelatin layer.

e. Other Features. There are other accessories for this camera, but they are principally for use in ground rather than aerial photography. More information is given in TM 11-6720-201-15.

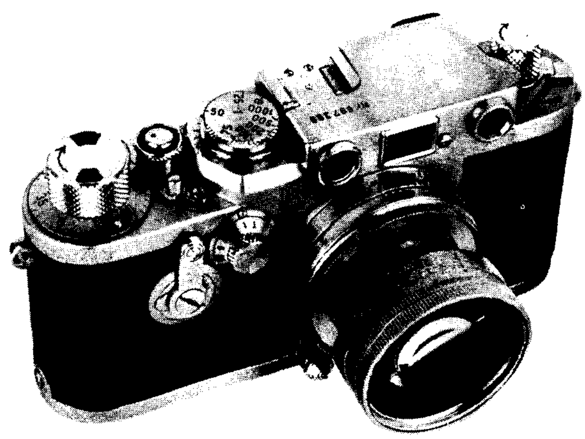
17-4. Aerial Operation of KE-15(1)

Basically the KE-15(1) is a ground photography camera, and its operation in aerial photography is the same as on the ground. Here are a few points to keep in mind—

a. Make certain that the camera's view is not obstructed. This is a hand-held camera with complete freedom of movement. During your excitement of approaching and photographing the target, you could easily unintentionally position the camera so that part of the aircraft blocks the camera's view of the target.

b. Steady the camera against your cheek and keep as much of your body as possible from touching the aircraft, thereby reducing the effect of aircraft vibration.

c. Swing the camera just fast enough to keep the target steady in the viewfinder. A smooth operation is most important and becomes more criti-



TM 401-2-1701

Figure 17-1. Still Picture Camera KE-15(1).

cal the lower the altitude and the faster the aircraft. This camera is *not* recommended for strips or mosaics, but if used for them, *do not* swing the camera.

d. At the correct instant, make the exposure by applying a steady squeeze to the shutter trigger.

17-5. General Description of KE-4(1)

The principal component of Still Picture Camera Set KS-6(1) is Still Picture Camera KE-4(1) (fig. 17-2). The KE-4(1) is a rugged, portable, hand-held, 70-mm roll film unit, particularly designed for photography under difficult operational and weather conditions. Although it is not specifically an aerial camera, it is useful for odd-angle and pinpoint air pictures.

17-6. Technical Characteristics of KE-4(1)

a. Film. The KE-4(1) uses a 15-foot roll of 70-mm, double perforated film. The film is loaded into a daylight-loading cassette. It provides up to 50 exposures. Each negative is 2-7/32 by 2¾ inches.

b. Lenses. The set includes two interchangeable lenses—an 8-inch and a 4-inch. If available, you can also use Camera Lens PH-666/PF, a 2½-inch wide-angle lens. It is not part of the set. Each of the set lenses is marked with a red dot to use as a focusing index for infrared photography. The longer focal length lenses are preferred for aerial photography.

c. Shutter. The self-capping, focal plane shutter has speeds from 1 to 1/1,000 second.

d. Filters. The set includes five colored gelatin sandwich filters—red (A), orange (G), medium yellow (K2), green (X1), and No. 87 infrared.

e. Other Features. The camera has a built-in, one-window rangefinder and optical viewfinder, an automatic viewfinder adjustment, a film cutoff knife, and an exposure counter negative numbering device. The camera is operated by a self-contained, hand-wound, spring-driven motor that you must rewind after 7 to 10 exposures.

17-7. Aerial Operation of KE-4(1)

The operation of the KE-4(1) is almost the same as the operation of Still Picture Camera KE-15(1). The one difference is that the KE-4(1) has a spring-driven motor.

17-8. General Description of KE-12(2)

a. Still Picture Camera KE-12(2) (fig. 17-3) of Still Picture Camera Set KS-4A(2) has some features that make it undesirable for aerial work. It has, however, two distinct advantages over the previously discussed cameras: (1) it has a large negative size; and, (2) it is easily adapted for diffusion transfer reversal (polaroid) film. On missions of the utmost urgency, the diffusion transfer reversal film eliminates the processing time. Finished prints are available almost immediately after you take the picture.

b. The KE-12(2) is a general purpose camera that is larger than the KE-15(1) and KE-4(1).

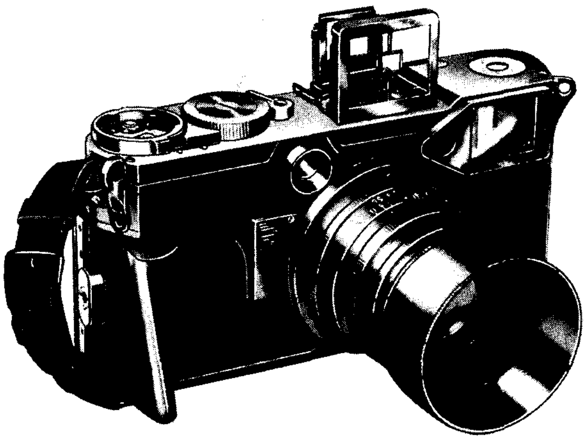


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Figure 17-2. Still Picture Camera KE-4(1).

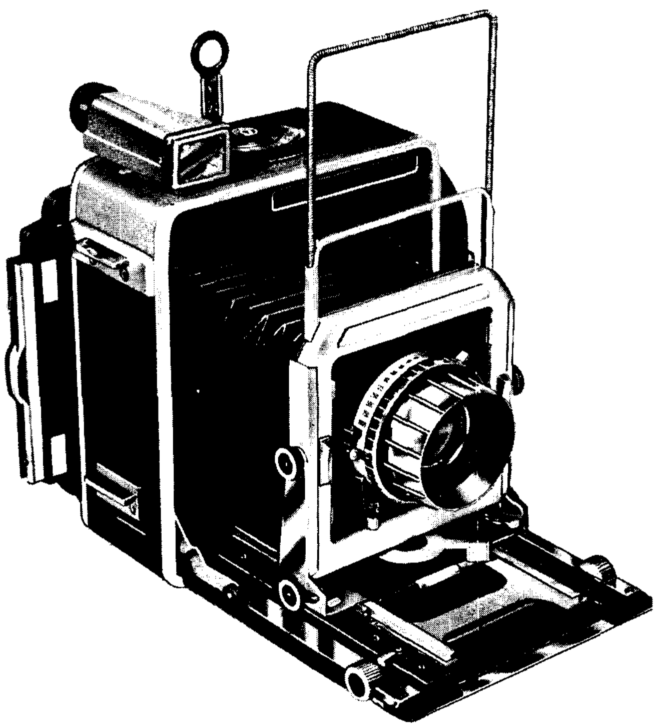

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Figure 17-3. Still Picture Camera KE-12(2).

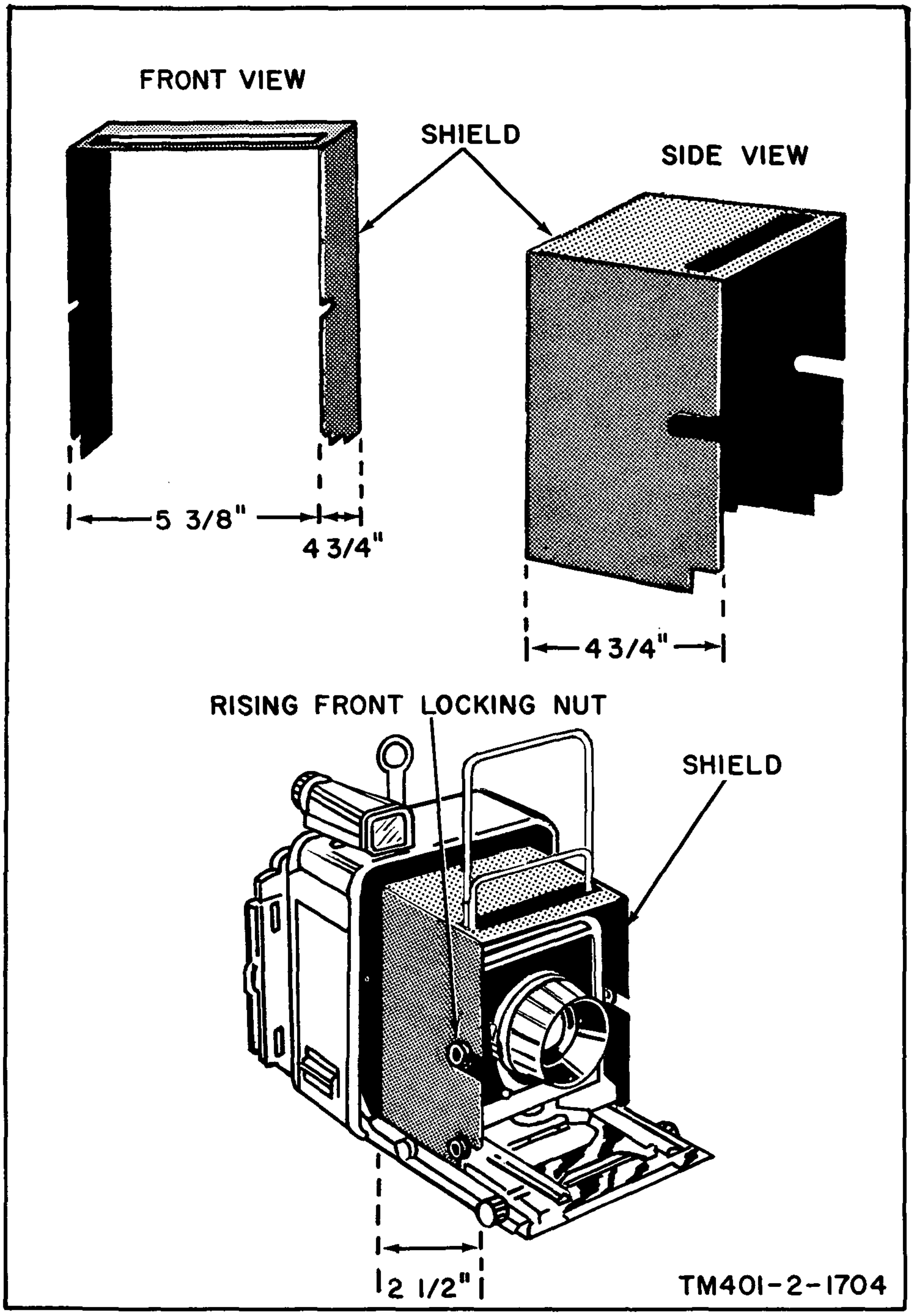


Figure 17-4. A shield for the KE-12(2).

It uses 4- by 5-inch cut film and film pack. This limits the number of photographs and the speed at which you can take exposures. The number of photographs you can take depends on how much room you have to carry film, and the speed depends on your manual dexterity.

c. Because of its bellows, you cannot extend the KE-12(2) beyond the aircraft fuselage without using a protective shield. The shield is not a part of the set, but you can construct one (fig. 17-4).

17-9. Technical Characteristics of KE-12(2)

a. Film. The KE-12(2) uses 4- by 5-inch cut film or film pack. You can adapt the camera for diffusion transfer reversal film by attaching a Polaroid 4- x 5-inch film holder.

b. Lens. The KE-12(2) has a 135-mm, f/4.5 coated lens.

c. Shutters. The camera has a between-the-lens shutter with exposure speeds from ½ to 1/1,000 second.

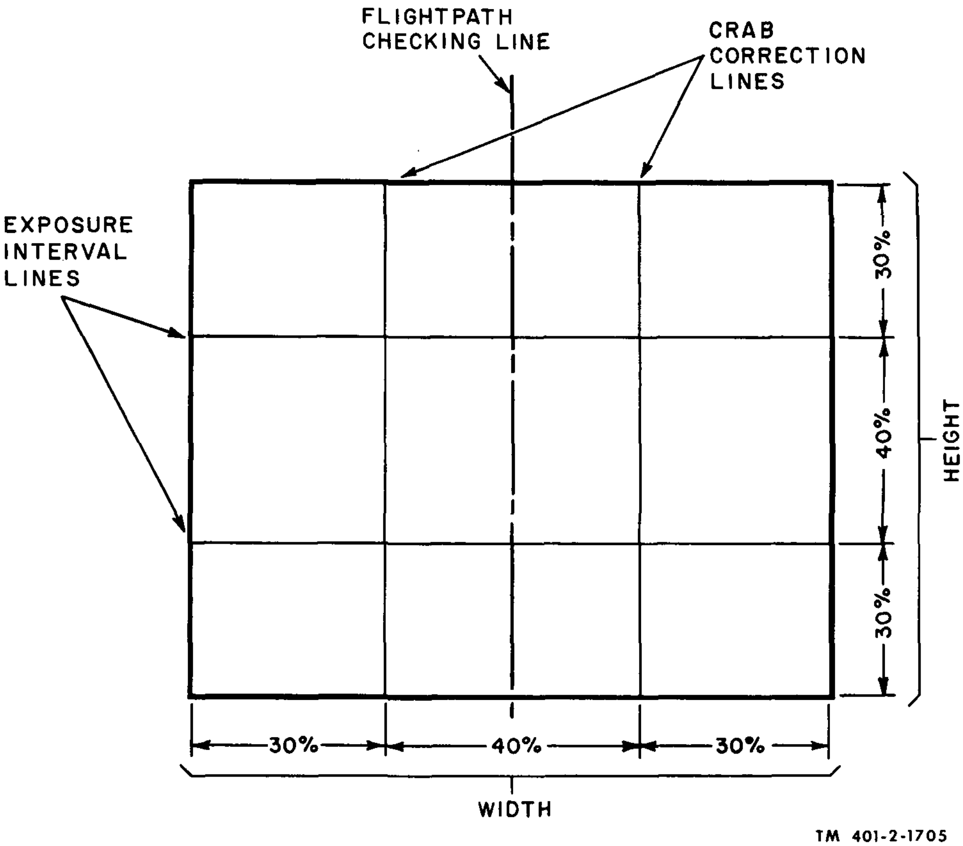


Figure 17-5. Viewfinder marking.

d. Other Features. The camera has rising, shifting, and tilting front controls. Make sure these controls are adjusted for normal operation in aerial photography.

17-10. Aerial Operation of KE-12(2)

Operating the KE-12(2) is generally the same as operating the KE-15(1). Refer to paragraph 17-4.

17-11. How to Mark and Use Viewfinder

To use a viewfinder for checking the flightpath, obtaining the proper overlap, and controlling the exposure interval, you should mark the viewfinder as explained below and shown in figure 17-5.

a. How to Mark and Use Flightpath Checking Line. Draw a line directly down the middle of the viewfinder so that the width of the viewing area is divided in two. Normally the longer dimension of the format is sideways to the direction of the flight and the shorter dimension is in line with the direction of the flight. During the mission, you should see images of objects on the flightpath moving along the flightpath checking line.

b. How to Mark and Use Crab Correction Lines. When the aircraft slides sideward as it moves forward this is called *crabbing.* Wind hitting the side of an aircraft will push the plane sideward, so that in order to fly directly over a given path the pilot may have to head the plane in a different direction. You can see this procedure in figure 17-6. The difference between the direction that the plane is heading and the actual direction that the plane is moving is the crab angle. Crab correction lines are used to indicate the crab angle. All objects you see should pass across the viewfinder parallel to the crab correction lines. Draw crab correction lines parallel to the flightpath checking line as follows:

Step 1. Measure the width of the viewfinder and assume it is 5 inches.

Step 2. Multiply the width by 3/10.

$$\frac{3}{10} \times 5 = \frac{15}{10} = 1\frac{1}{2}$$

Step 3. Place a line in from each side of the viewfinder the distance determined in step 2 above. The crab correction lines are 1½ inches in from each side.

c. How to Mark and Use Exposure Interval Lines. To provide a 60-percent overlap on adjacent exposures the scene must shift 40 percent. Thus, you need to draw exposure interval lines 40 percent of the view apart. You will get a 60-percent overlap by either making the first expo-

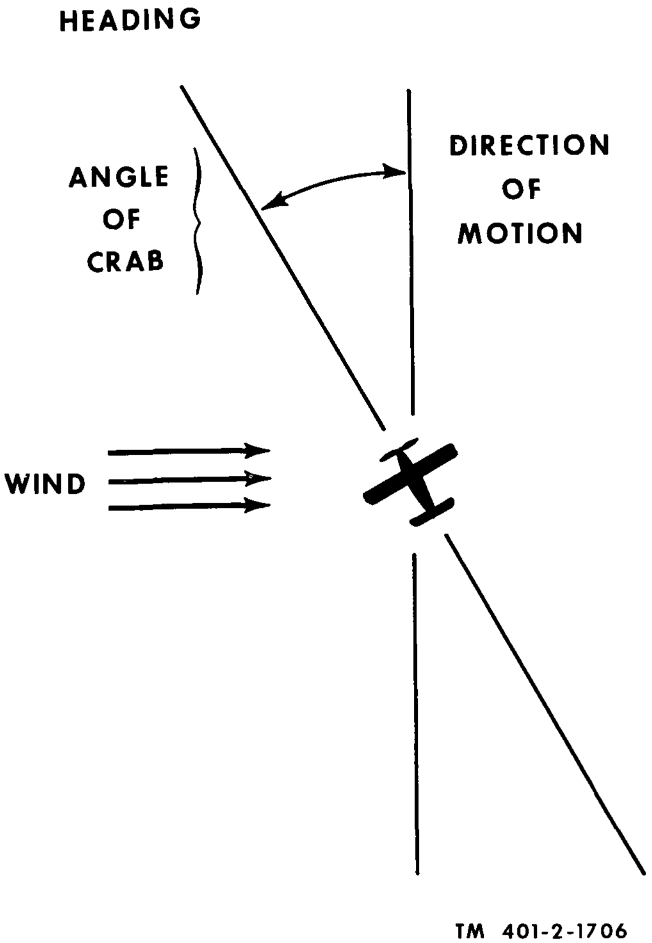


Figure 17-6. Crabbing.

sure as an object's image crosses the first line and the second exposure when the same image crosses the second line, or by timing with a stopwatch the time required for the image of an object to move from one line to the other line and using the time to pace the exposures. You determine the position of the exposure interval lines as follows:

Step 1. Measure the height of the viewfinder.

Step 2. Multiply the height by 3/10.

Step 3. Place a line in from the forward and rear edges of the viewfinder the distance determined in step 2 above. You can see how to do this in figure 17-5.

17-12. General Description of KA-7(1) and KA-24A

Still Picture Cameras KA-7(1) (fig. 17-7) and KA-24A (fig. 17-8) are lightweight, hand-held, electrically operated, semiautomatic cameras designed specifically for aerial photography. The two cameras are almost identical except that the KA-24A can be operated automatically by connecting it to the Camera Control Group LA-13A (ch. 18). Unless otherwise stated, any reference in this text to one of these cameras applies also to the other.

17-13. Technical Characteristics of KA-7(1) and KA-24A

a. Film. The cameras use aerial roll film $5\frac{1}{4}$ inches wide and 20 feet long. Each roll can give fifty-five 4- by 5-inch negatives.

b. Shutter. Both cameras have between-the-lens shutters with speeds of 1/125, 1/250, and 1/500 second.

c. Lens. The camera lens is $6\frac{3}{8}$-inch anastigmatic with a maximum aperture of f/4.5. The focus is fixed and set at infinity.

d. Filter. The cameras have a minus-blue filter.

e. Other Features. Both have a folding optical viewfinder for use when the cameras are hand-held. For taking vertical aerial photographs, the cameras can be installed in Aircraft Camera Mount LM-39(1) or LM-39A.

17-14. How to Use Camera Mount LM-39

a. Aircraft Camera Mounts LM-39(1) and LM-39A are basically the same although there are mechanical differences. The LM-39A looks much like the LM-39(1) shown in figure 17-9.

b. The camera mount is a mechanical, electrically operated device controlled by a manual level. It is designed to keep an aerial camera in the vertical position in an L-19 aircraft. You can use the unit with a variety of aerial cameras and for

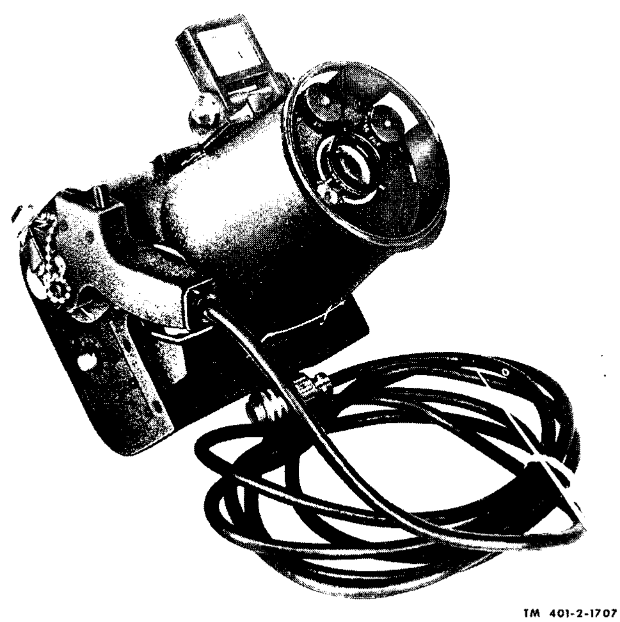


Figure 17-7. Still Picture Camera KA-7(1).

Figure 17-8. Still Picture Camera KA-24A.

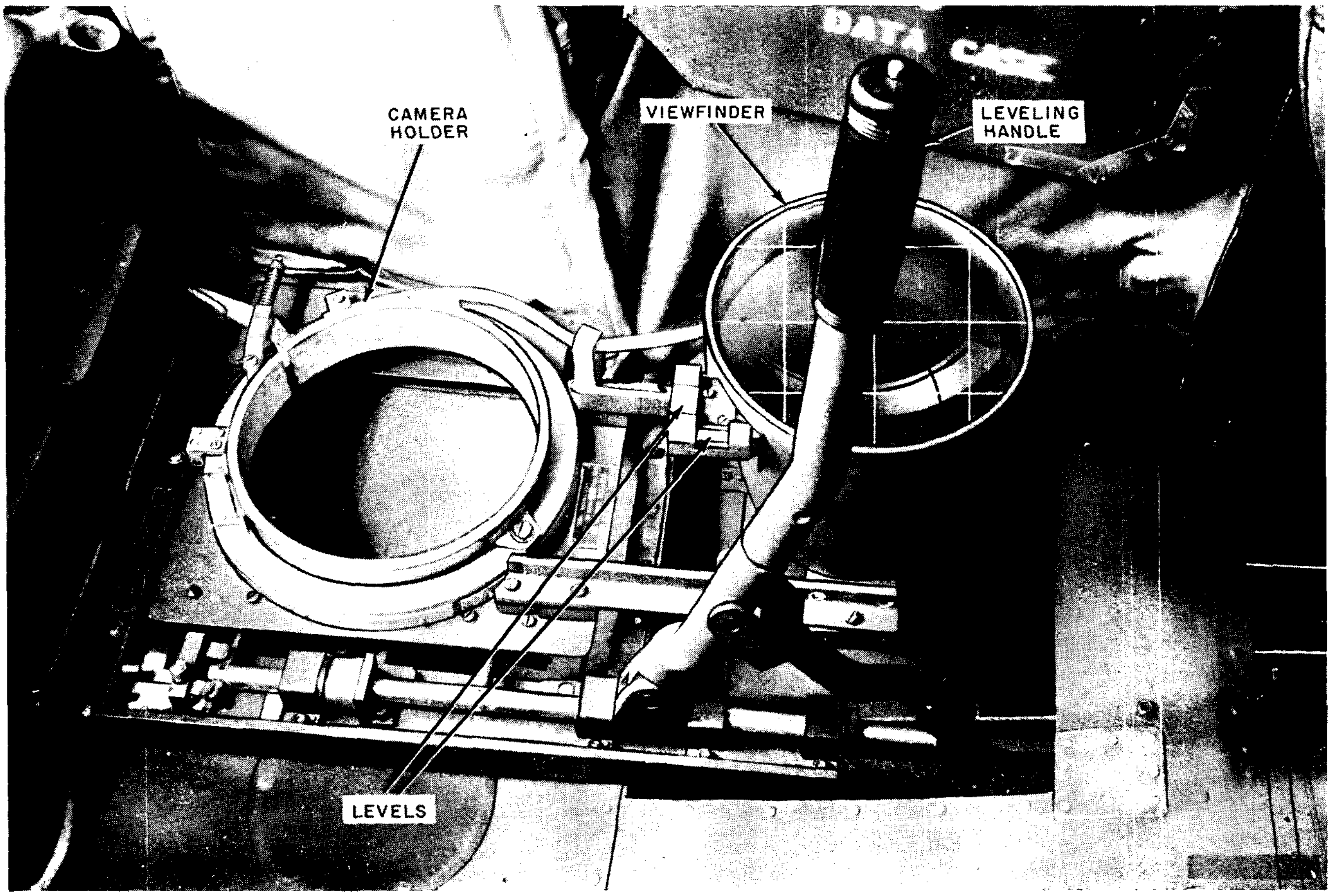


Figure 17-9. Aircraft Camera Mount LM-39(1).

all types of vertical photography, but it is particularly useful for producing strips and mosaics.

c. The equipment consists of a camera holder and a viewfinder mounted on a movable framework, a detachable leveling handle, two levels mounted at right angles to each other, and a mounting base. The camera holder and the viewfinder are linked mechanically so they can be rotated together through identical arcs.

d. The built-in viewfinder gives control of the parallel position of the film plane with respect to the ground and provides pictorial control.

17–15. How to Load KA–7(1) and KA–24A

a. Clean the inside of the camera; remove dust with an air syringe. If any dirt or bits of emulsion remain that you cannot remove with a clean, dry cloth, use an orange stick or a toothpick that is moistened in an approved cleaning fluid.

b. Engage the wind-handle key with the end of the wind-handle key shaft. Slowly turn the wind-handle key clockwise until the arrow engraved on the key points directly down toward the camera cone—this is the loading position.

c. Now, remove the cover assembly and check the position of the ratchet stop spring. With the camera in the loading position, the ratchet stop spring should be dropped away from the teeth on the ratchet. If the ratchet stop spring contacts the ratchet teeth, turn the wind-handle key slowly clockwise until the ratchet stop spring drops out of engagement with the ratchet teeth.

d. Insert the film threading plate under the film roller, the pressure plate, and the film metering roller (fig. 17–10).

e. Remove the unexposed film from its container.

f. Insert the unexposed roll of film into the camera between the supply spool friction plate and the film spool leaf spring so that the film will feed out from the bottom of the spool (toward the front of the camera).

g. Draw out about 10 inches of film leader and thread it over and around the film roller. Pass the film leader between the pressure plate and the film threading plate, toward the takeup spool. As the film leader comes through at the takeup spool side of the camera, pass it between the pressure and film metering rollers (fig. 17–10).

h. Lift the pressure roller against its spring and straighten and aline the film leader.

i. Insert the end of the film leader into the slot in the center of the takeup spool. Rotate the spool, winding on about two turns of film leader. Feed the film onto the spool from the bottom side (toward the front of the camera).

j. Insert the takeup spool into position in the camera in the following manner:

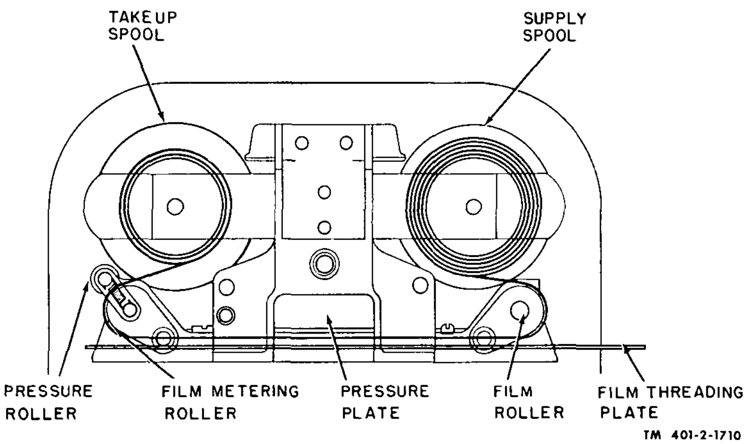


Figure 17–10. Film threading diagram.

(1) Pull out the end of the film spool leaf spring, and engage the cutout in the end of the takeup spool with the film takeup assembly key.

(2) Release the film spool leaf spring, and position the takeup spool so that the pivot on the film spool leaf spring engages the takeup spool.

k. Turn the film takeup knob just far enough to take up slack in the film leader. If the film takeup knob locks or is difficult to turn, the wind-handle key may not be precisely in the loading position. In this case, again wind and trip the camera so that the wind-handle key points downward directly toward the camera cone.

l. Check the loading.

m. Remove the film threading plate.

n. Replace the cover assembly.

o. Remove the wind-handle key from the wind-handle key shaft, and replace the key in its holder on the switch handle assembly.

17–16. How to Operate KA–7(1) and KA–24A

Perform the first four steps of the operating procedure (*a* through *d* below) as soon as possible after loading the camera. Then, perform the next six steps (*e* through *j* below) before reaching the target area. Here's the operating procedure.

a. Connect the keyed connector on the end of the power cable to a 24-volt, direct current (dc) power supply. Securely tighten the retainer ring on the connector. Connect the cable to the power supply so that it will not interfere with either the aircraft controls or your photographing.

b. Turn the exposure counter to the 0 setting.

c. Press and hold the trigger switch for eight exposures. The switch is actually released after the seventh exposure cycle. This procedure winds the film leader.

d. Reset the exposure counter to the 0 setting. If the counter is not reset at this stage, you will lose several exposures at the end of the film.

e. Press the viewfinder projecting leaf spring and raise the viewfinder to the viewing position.

f. Remove the lens cap.

g. If necessary, dust and clean the lens carefully.

h. If you need the minus-blue filter, attach it to the front of the lens.

i. Set the lens aperture.

j. Set the shutter speed. The click stops permit precise settings.

k. When the camera is hand-held and you have no camera mount, hold the camera firmly, using your body for support. Never rest the camera against the aircraft, and keep the camera out of the air slipstream.

l. Sight the target through the viewfinder. Center the target in the crosshairs, guided by the rear sight.

m. Press and hold the trigger switch for the desired number of exposures. Release the trigger switch to stop film exposure. The camera mechanism automatically stops regardless of the trigger switch position when the exposure counter reaches 59.

17–17. How to Unload the KA–7(1) and KA–24A

a. Remove the power cable connector from the power supply.

b. Engage the wind-handle key with the wind-handle key shaft, and turn the wind-handle key to the loading position (arrow on the wind-handle key pointing straight down).

c. Turn the film takeup knob clockwise about 10 turns to wind the film trailer onto the takeup spool.

d. Remove the cover assembly.

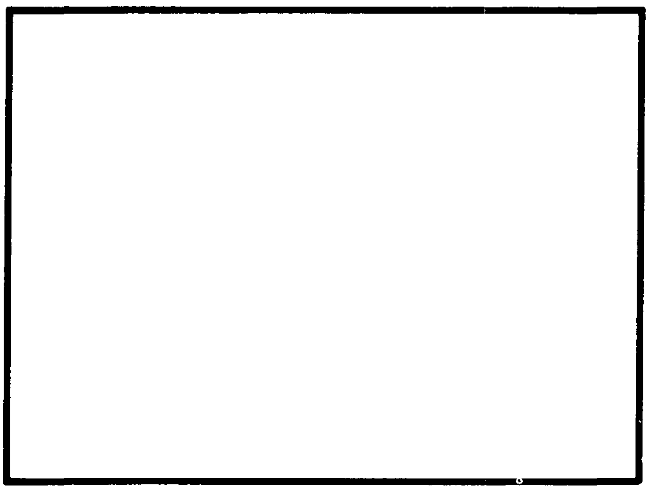
e. Lift the film spool leaf spring from the takeup spool, and carefully remove the takeup spool to prevent the film from unwinding. Tape the end of the film trailer, and place the spool of film into the film can.

17–18. Summary

Table 17–I summarizes characteristics of the manual and semiautomatic aerial cameras we have discussed in this chapter.

a. The manual cameras we discussed are basically ground rather than aerial cameras, and although you may use any camera in the air, we recommend those discussed here.

b. You should mark the viewfinder to check flightpath, to obtain overlap, to control the ex-



TM 401-2-1712

Figure 17–11. Viewfinder marking problem.

Table 17-I. Characteristics of Manual and Semiautomatic Aerial Cameras

Camera	KE-15(1)	KE-4(1)	KE-12(2)	KA-7(1)	KA-24A
Set	KS-15(1)	KS-6(1)	KS-4A(2)		
Type	Manual	Manual	Manual	Semiautomatic	Semiautomatic
Film:					
Size	35 mm	70 mm	Cut film or film pack	20 ft aerial roll	20 ft aerial roll.
Negatives	1 x 1½ in	2⁷⁄₃₂ x 2¾ in	4 x 5 in	4 x 5 in	4 x 5 in.
Exposures	20 to 30	50		55	55.
Lens	35 mm 50 mm 135 mm.	4 in 8 in.	135 mm	6⅜ in	6⅜ in.
Shutter	Focal plane 1 to 1/1000 sec.	Focal plane 1 to 1/1000 sec.	Between-the-lens ½ to 1/1000 sec.	Between-the-lens 1/125, 1/250, and 1/500 sec.	Between-the-lens 1/125, 1/250, and 1/500 sec.
Filters	Orange (G)	Red (A), Orange (G), Medium yellow (K2), Green (XI), No. 87 Infrared.		Minus-blue	Minus-blue.

posure interval, and to correct for crabbing.

c. Load and unload the semiautomatic cameras in subdued light. They will make sequential exposures as long as you hold the trigger switch. When they are mounted in Aircraft Camera Mount LM-39, the semiautomatic cameras can be used for vertical photography.

d. Still Picture Camera KA-24A becomes automatic when you use it with Camera Control Group LS-13A.

17-19. Review Questions

a. Is Still Picture Camera KE-4(1) a manual or a semiautomatic camera?

b. What advantages does the KE-12(2) have over the KE-15(1) and KE-4(1) for aerial photography?

c. What is the difference between the KA-7(1) and the KA-24A?

d. Assume the rectangle in figure 17-11 is a viewfinder, and draw the flightpath checking line, the crab correction lines, and the exposure interval lines.

17-20. Answers to Review Questions

a. Manual.

b. The negative size is larger, and it can use diffusion transfer reversal film.

c. The KA-24A can be used with Camera Control Group LA-13A for automatic operation.

d. Refer to the answer in figure 17-12.

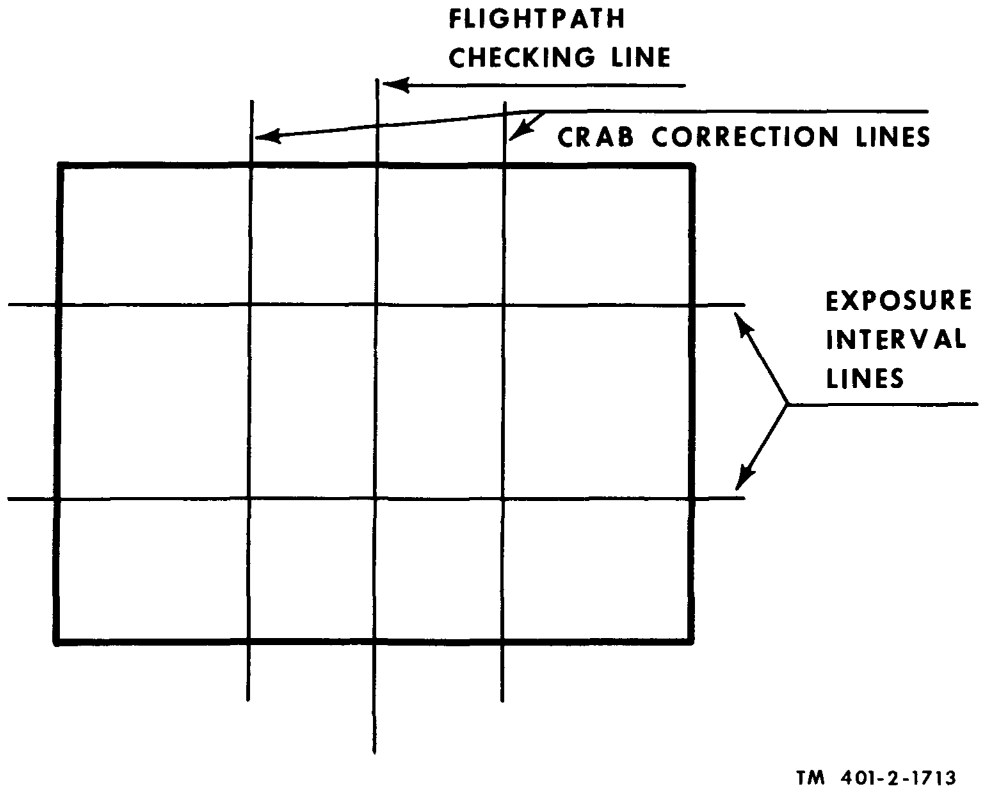


Figure 17-12. Answer to problem d.

CHAPTER 18

AUTOMATIC AERIAL CAMERA SYSTEMS

18-1. Introduction

a. The principal advantage of using automatic aerial cameras is the accuracy of exposure interval and overlap that you can obtain when making long strips or mosaics. From the time you turn on the automatic camera until the time you turn it off, it makes regularly spaced exposures. The spacing is determined by electronic control circuits and preset adjustments.

b. Because the automatic camera need only be turned on and off at the proper time, it can be used in either an unmanned (drone) aircraft or a manned (piloted) aircraft.

c. The operation of an automatic aerial camera as stated above sounds very simple, but we didn't mention such steps as loading and unloading film, presetting controls, installing the camera in the aircraft, making a preflight check of the system, and using the manual controls that are usually provided to override the automatic system. There are still many things that you must do manually, even though the camera system is automatic.

d. In this chapter we'll discuss how the semiautomatic Still Picture Cameras KA-23A and KA-24A are operated automatically, how to use the Automatic Still Picture Camera KA-20A and KA-39A, and how the Photographic Surveillance System KS-61A operates. Also we'll discuss Camera, Still Picture KA-60B and Camera, Still Picture KA-76A.

18-2. Automatic Operation of KA-24A

The semiautomatic operation of the Still Picture Camera KA-24A was discussed in chapter 17. The basic difference between the semiautomatic and the automatic operation is that for automatic operation the camera is connected to the Camera Control Group LS-13A.

18-3. How the LS-13A Works

a. Camera Control Group LS-13A is used for automatic, daylight aerial photography. It consists of Intervalometer B-3B and a camera control box. The intervalometer is an electrical timing device that will trip the camera's shutter at regularly spaced time intervals. The time of the interval can be any whole number of seconds between 2 and 120 as determined by the photographer.

b. The camera control box is a junction box that provides a common tie-in point for the intervalometer, the camera, and the aircraft's 24-volt direct current supply.

c. To operate the Camera Control Group LS-13A you first make connections to the camera and the 24-volt supply. Next, set the intervalometer for the proper exposure interval. (Determining the exposure interval is described in chapter 14.) Then simply turn the system on at the beginning of the strip and turn it off at the end of the strip.

d. The two signal lights of the Camera Control Group LS-13A aid in the operation. The lamp on the control box lights when the film is transported in the camera, so if it's not lit it means trouble. The lamp on the intervalometer lights 2 seconds before exposure so you can check the exposure rate or the scene being photographed.

18-4. A Simple Automatic System

a. Still Picture Camera KA-20A (fig. 18-1) is an automatic, daylight, vertical aerial camera. It is a simple automatic system. During the flight the photographer just turns it on and turns it off; the camera does the rest.

b. When you turn it on, the camera makes an exposure, and the number of the exposure is recorded on the edge of the film by the recording dial. Then the film is moved for the next exposure. The next exposure is made at the correct time for a 60-percent overlap, and this process is repeated over and over until the camera is turned off or until it runs out of film.

c. The Still Picture Camera KA-20A is mounted in a wing pod of a manned aircraft or the body of a drone. When used in a drone the camera is turned on and off from the ground by radio control, and in a manned aircraft the photographer has an ON/OFF switch in the cockpit to control the camera.

d. Still Picture Camera KA-20A uses aerial roll film that is 9.5 inches wide, 75 feet long, and can take up to 95 exposures per roll. Each exposure is 9 inches by 9 inches. The lens is an f/6.3 wide-angle with a 6-inch focal length. Minus-blue and Wratten No. 25A filters are provided.

e. The camera requires an external source of 24 volts dc, 3.7 amperes, and a vacuum of 1 to 8 inches of mercury.

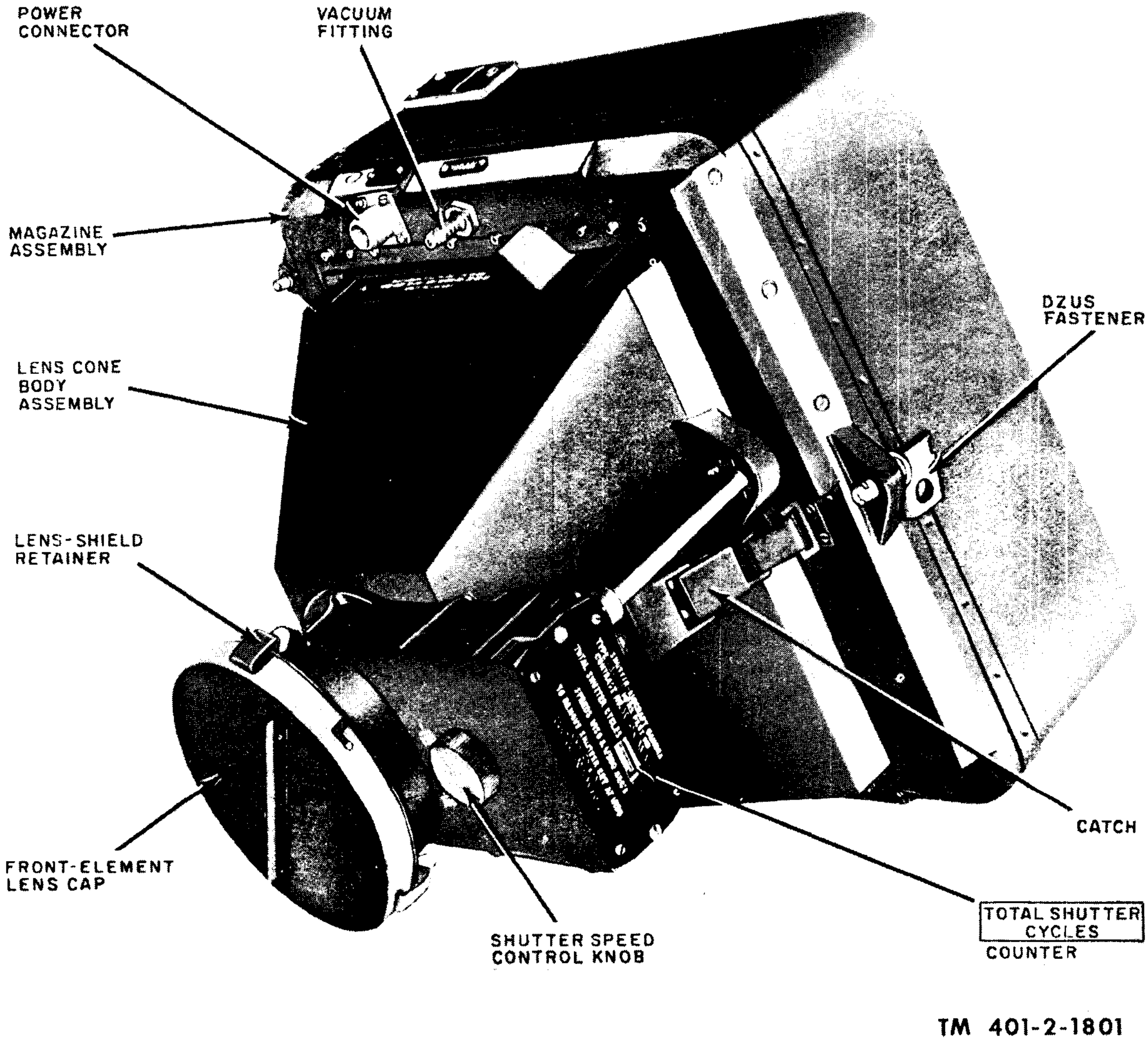


Figure 18-1. Still Pitcure Camera KA-20A.

f. The total cycle counter records each time the shutter operates and is used to indicate the need for general maintenance.

18-5. Preflight Operation of the KA-20A

Perform the following operations before the flight.

a. Check the operation and condition of the equipment. This is a general preventive maintenance type of check.

b. Remove the inside lens cap. This is a simple task—so simple that it is easily overlooked, and then the mission is a total failure.

c. Load the film. You may not need a full roll (75 feet, 95 exposures). Multiply the required number of exposures by 15 and then divide by 19. The result is the number of feet of film you'll need. When using only part of a roll allow a few extra feet for a leader. On a new roll the leader is 10 feet long.

d. Replace the cover.

e. Set the IMC (altitude adjustment) control as explained in paragraph 18-7.

f. Mark on the data plate the mission number, film type, etc.

g. Set the shutter speed control as explained in paragraph 18-8.

h. Install the camera in the aircraft. Be sure to connect both the power cable and the vacuum hose and to remove the outside lens cover.

i. Operate the camera through a few cycles to check the system.

j. A more thorough description of the operation of Still Picture Camera KA-20A is given in TM 11-6720-203-10.

18-6. IMC Stops Motion

IMC, which stands for image motion compensation, is an adjustment that prevents the blur that would normally appear when the camera is moved during the exposure. In aerial photography the aircraft is moving during the exposure. Thus, during the exposure when the shutter is open, the image of the terrain is moving on the film (fig. 18-2). If a high shutter speed is used, the image movement is slight and the amount of blur is small. However, when a low flying aircraft moves at a high speed, if the light intensity is low, or if a long focal length is used, the fastest permissible shutter speeds will not be sufficient to yield a usable negative. But with IMC, the film is moved with the moving image so that the image remains in one position on the film, and even at slow shutter speeds the negative will not be blurred.

a. IMC is performed by the film transport drive mechanism. In automatic cameras the film is moved through the camera by a system that includes a motor, gears, and rollers. The speed of this drive system is variable so that the film can be moved rapidly between exposures and at slow IMC rates during exposures. In some systems the IMC rate is automatically adjusted by a device called a Scanner-Scanner Converter, which actually measures the image motion. In some other systems the pilot or the photographer makes adjustments during the flight. And in systems like Still Picture Camera KA-20A, the IMC is set before the flight.

b. The amount of image motion increases with the aircraft speed. Thus IMC must increase with the speed of the aircraft.

c. Image motion also increases with an increase in focal length of the camera. Long focal length lenses see a smaller part of the terrain and so the image is enlarged on the film. As the image becomes bigger any image motion will appear more pronounced.

d. Image motion decreases with an increase in altitude. The farther away you get from an object the slower is its apparent motion. When you're sitting in a speeding car, telephone poles at the edge of the road appear to speed by in the opposite direction, while trees and houses off in the distance appear to move more slowly. Since you are the one that is actually moving, the relative motion of the poles and trees and houses is the same, but distance causes the image, in your eyes, of the trees and houses to move slower. Likewise, an increase in distance or altitude makes the image on the film move slower. Thus, IMC must increase with a decrease in altitude.

e. Image motion decreases with an increase in obliqueness. As the camera angle is changed from a vertical to a low oblique to a high oblique, the camera-to-subject distance increases, and the image motion decreases. Conversely, as the camera angle becomes less oblique and more vertical, the image motion increases. Consequently, IMC must increase as the camera angle becomes more vertical.

f. With the KA-20A, as with some other aerial cameras, setting the IMC is part of the preflight operation as is setting the exposure and loading the film.

18-7. How to Set the IMC Control on the KA-20A

a. In Still Picture Camera KA-20A, both the IMC and the exposure interval are set by one control—the altitude adjustment. Only one control is needed because the camera has a fixed focal length (6 inches), is designed for vertical aerial photographs only (it could be used for but it's not designed for obliques), and automatically provides a 60-percent forward overlap.

b. To determine the proper setting for the altitude adjustment control, divide the altitude (in feet) by the aircraft's groundspeed (in miles per hour) and multiply by 200. Because the control

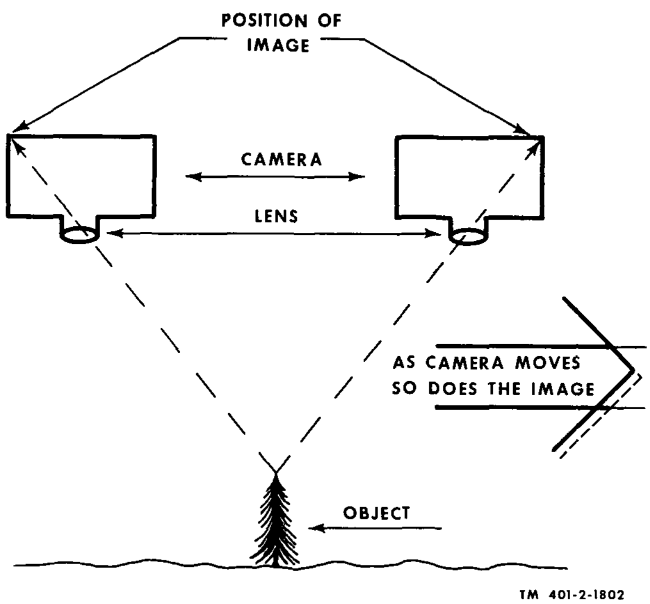


Figure 18-2. Image motion.

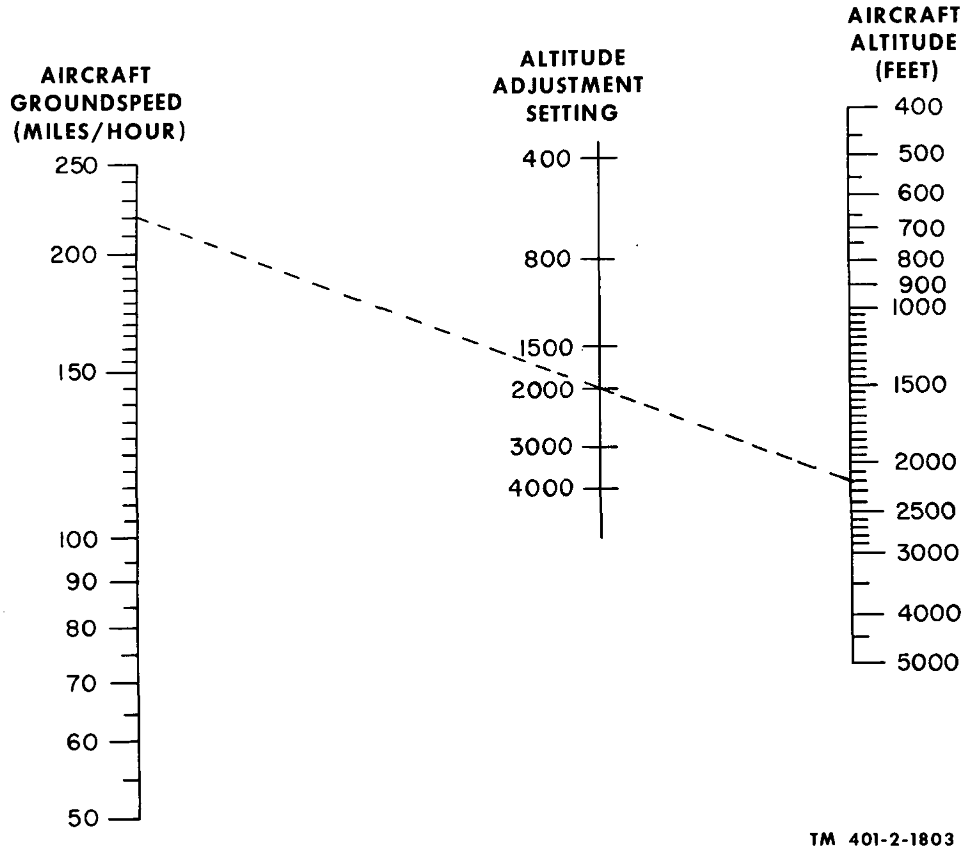


Figure 18-3. Altitude adjustment nomograph for KA-20A.

has discrete settings of 400, 800, 1,500, 2,000, 3,000, and 4,000, you may not be able to set it to the exact amount calculated.

c. To use one of the discrete settings, divide the altitude (in feet) by the numerical value of one of the settings and multiply by 200. Use the result as the aircraft groundspeed. *For example,* with an altitude of 2,200 feet and an altitude adjustment setting of 2,000, the result is 200 x 2200/2000 = 220. So the groundspeed of the aircraft should be 220 miles per hour. Always select a setting that will put the groundspeed near 200 miles per hour.

d. You can use the nomograph of figure 18-3 instead of the mathematical calculations. Any straight line that intersects the scales will intersect them at the correct combination of groundspeed, altitude adjustment setting, and altitude. *For example,* the dashed line in the illustration shows a combination of 220 miles per hour groundspeed, an altitude adjustment setting of 2,000, and altitude of 2,200 feet.

18-8. How to Set Shutter Speed Control and Select Filter for KA-20A

Table 18-I gives the exposure and filter information for Still Picture Camera KA-20A. To use the table, first estimate what the terrain bright-

Table 18-I. Shutter Speed and Filter for KA-20A

Terrain brightness (foot-lamberts)		Speed	Filter
1,500-800	Brilliant	1/300	Minus-blue (yellow) or Wratten #25A (red).
800-400	Bright	1/300	Minus-blue (yellow).
		1/150	Wratten #25A (red).
400-200	Average	1/150	Minus-blue (yellow) or Wratten #25A (red).
200- 50	Dark	1/150	Clear or none.

ness of the target area will be. You'll find the proper setting of the shutter speed control knob (fig. 18-1), and the filter that should be used, to the right of the terrain brightness in table 18-I.

18-9. Inflight Operation of KA-20

To operate the camera during the flight, simply turn it on and off at the proper time. However, because the IMC control is set for a specific combination of altitude and speed, the pilot must fly at the predetermined altitude and speed. Also, the aircraft should be level during the exposures. You must observe and note terrain features for caption data because the automatic system does not prepare captions—this is still your task.

18-10. Postflight Operation of KA-20A

After the flight remove the camera from the aircraft. Check the FILM REMAINING indicator. If some of the film was not used, remove the film from the camera in a darkroom. Cut the exposed portion from the unused portion and retain the unused film for future use.

18-11. A Day-Night Automatic System

Still Picture Camera KA-39A (fig. 18-4) is very much like Still Picture Camera KA-20A. The major difference is that the KA-39A can be used at night as well as in the daytime.

a. Day operation of Still Picture Camera KA-39A is the same as for the KA-20A described in paragraph 18-4, except that the lens opening is f/8 for day and f/4 for night. Also, no external vacuum source is required.

b. In night operation the photographer turns the camera system on with the POWER switch on the control box (fig. 18-5). The CAMERA RUNNING indicator lamp lights to show that power is applied to the camera. The shutter opens, and the film moves at the IMC speed. An electrical pulse from the camera causes a flare (photoflash cartridge) to eject. After the flare bursts, its

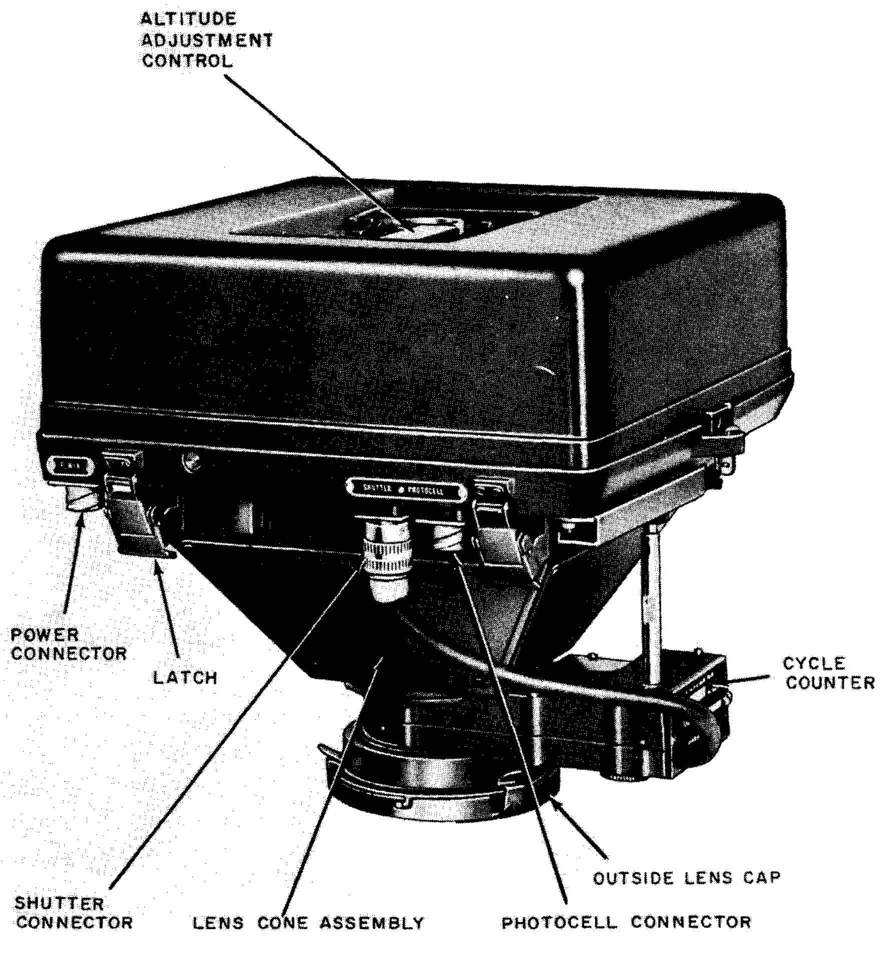


Figure 18-4. Still Picture Camera KA-39A.

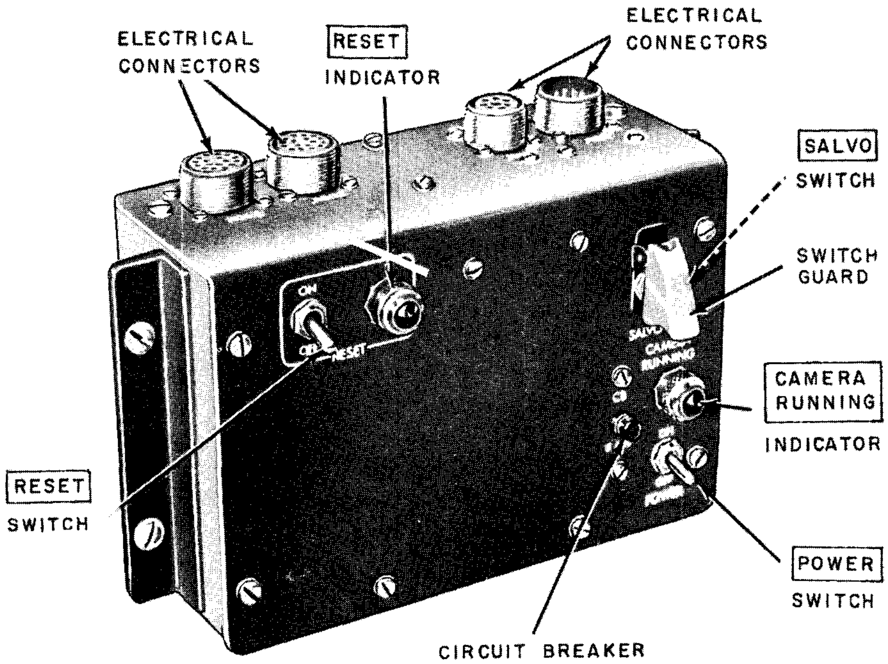


Figure 18-5. The control box.

light is reflected off the terrain to expose the film and activate the photocell. The photocell then sends an electrical pulse to the camera, the shutter closes, and the film moves to position for the next exposure. This process repeats itself at an interval that provides 60-percent overlap.

18–12. Preflight Operation of KA–39A

The following operations should be performed on the KA-39A before the flight:

a. Check the equipment.

b. Remove the inside lens cap.

c. Load the film.

d. Mark the mission number, film type, etc., on the data plate.

e. Replace the cover.

f. Set the IMC (altitude adjustment) control as explained in paragraph 18-13.

g. Set the DAY/NIGHT control.

h. Set the shutter speed control. This control is set the same as for the KA-20A (para 18-8) except that at night use only the 1/150 setting.

i. Install the filter. This is the same as for the KA-20A (para 18-8), except that at night use only a clear filter.

j. Install the camera in the aircraft (fig. 18-6).

k. Operate the camera through a few cycles to check out the system. The flares will not eject because an air safety switch disconnects power from the flare ejectors until the aircraft is airborne.

l. For a night mission, operate the RESET switch on the control box until the RESET indicator lights. This sets the flare system so that the flares will eject in sequence, starting with flare number one.

m. A more detailed description of the operation of Still Picture Camera KA-39A is given in TM 11-6720-207-10.

18–13. How to Set the IMC Control

a. One control, the altitude adjustment (IMC) control (fig. 18-7), sets both the IMC and the exposure interval. The correct IMC and proper interval for 60-percent overlap of vertical photographs is set according to the aircraft's speed and altitude.

b. To determine the proper setting for the altitude adjustment control, first select either the 200 MPH or the 100 MPH range. Use the 200 MPH range for speeds between 100 and 250 miles per hour and altitudes between 500 and 5,000 feet. Use the 100 MPH range for speeds between 50 and 200 miles per hour and altitudes between 2,500 and 10,000 feet.

(1) *200 MPH range.* To obtain the altitude adjustment control setting when using the 200

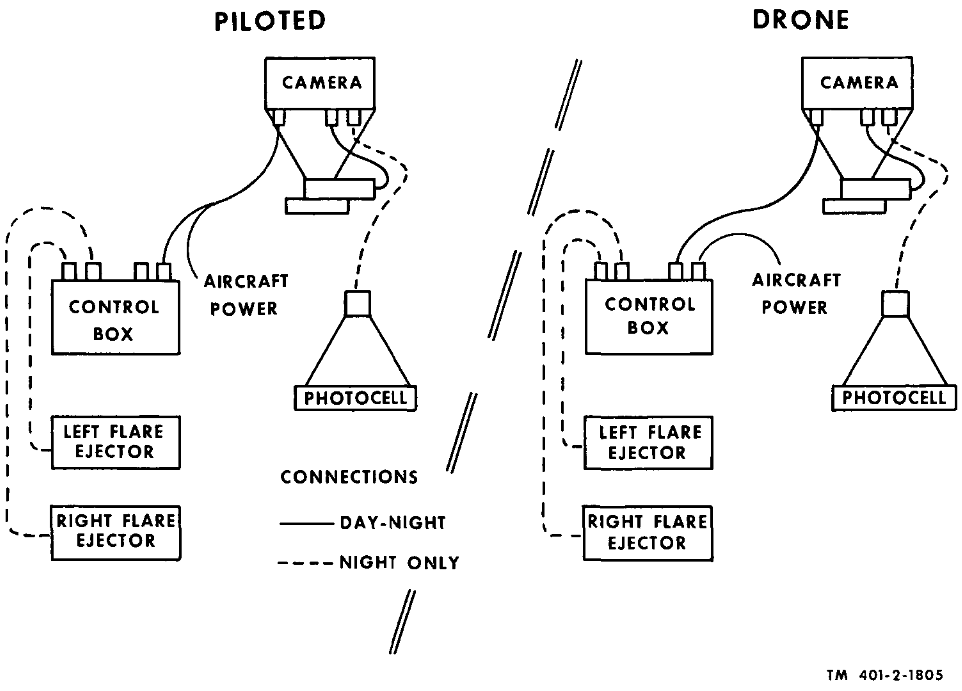


Figure 18–6. Cable connections for KA–39A.

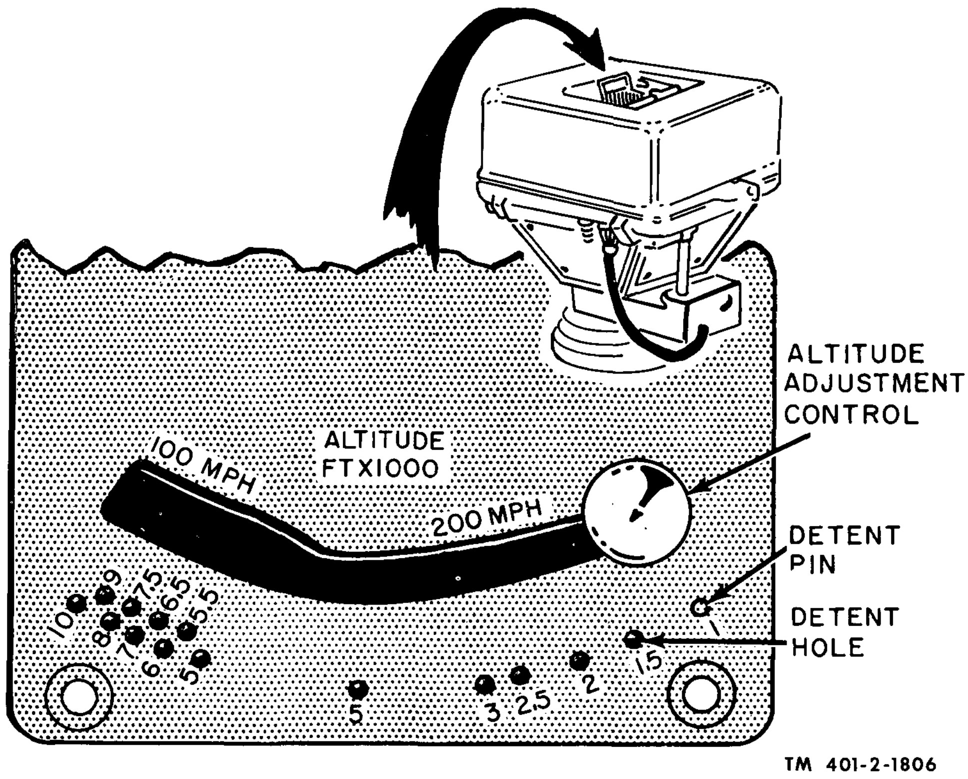


Figure 18–7. The altitude adjustment control.

MPH range, divide the altitude (in feet) by five times the aircraft's groundspeed (in miles per hour), as follows:

Setting = altitude/5 x groundspeed. Because the control has discrete settings of 1, 1.5, 2, 2.5, 3, and 5 in the 200 MPH range, you may not be able to set it exactly to the setting you calculate. You can, however, obtain an exact setting by interchanging the setting and groundspeed in the formula. Then, select a desired setting, and calculate what the groundspeed should be.

(2) *100 MPH range.* To obtain the altitude adjustment control setting when using the 100 MPH range, divide the altitude (in feet) by 10 times the aircraft's groundspeed (in miles per hour), as follows:
Setting = altitude/10 x groundspeed. The control has discrete settings of 5, 5.5, 6, 6.5, 7, 7.5, 8, 9, and 10 in this range, and you may not be able to set it exactly to the calculated setting. As in (1) above, you can obtain an exact setting by interchanging the setting and the groundspeed in the formula. Select a desired setting, and calculate what the groundspeed should be.

c. Instead of calculating the altitude adjustment control setting, you can use the nomograph in figure 18-8 to determine what it should be. Any straight line that intersects all three scales will intersect at the correct combination of groundspeed, altitude adjustment control setting, and altitude. *For example,* the dashed line shows that at a groundspeed of 220 miles per hour, the setting should be 2, and the altitude should be 2,200 feet.

18-14. Inflight Operation of KA-39A

Inflight operation of Still Picture Camera KA-39A is the same as for Still Picture Camera KS-20A (para 18-9), except for the flares. If there are any flares left over after photographing or in case of an emergency, the flares should be ejected before landing. To dispose of the flares quickly, lift the guard on the SALVO switch and hold the switch in the SALVO position until the flares have been ejected. If a flare fails to eject, then use the RESET switch to reset the flare ejection system and then resalvo.

18-15. Postflight Operation of KA-39A

The postflight operation of Still Picture Camera KA-39A is the same as for Still Picture Camera KA-20A (para 18-10).

18-16. Camera, Still Picture KA-60B

a. General. The KA-60B is a moving film, panoramic aerial camera that provides horizon-to-horizon reconnaissance capability for high speed, low flying aircraft. The camera is used in a forward oblique position. It shows a complete picture of the ground directly beneath the aircraft (for-

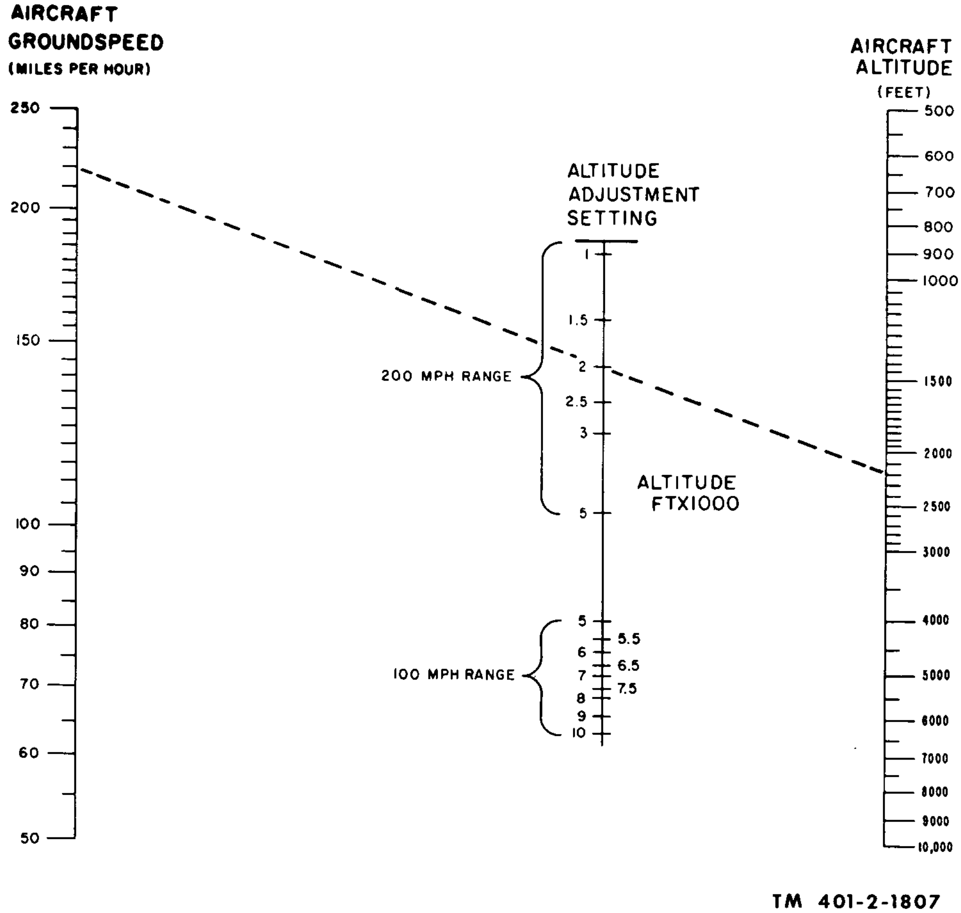


Figure 18-8. Altitude adjustment nomograph for KA-39A.

ward horizon and both lateral horizons).

b. Technical Characteristics. The KA-60B has a scan angle of 180 degrees and has a 3-inch, f/2.8 lens. It has automatic exposure control. The film format is approximately 2.25 by 9.4 inches. The KA-60B has two modes of operation—autocycle and pulse. It operates at 2 cycles per second (cps) or 4 cps in the autocycle mode, and up to 1 cps maximum in the pulse mode.

18-17. Components of the KA-60B

The KA-60B has four components: the body, magazine, control panel and the camera controls box.

a. Within the camera body (fig. 18-9) are the prism, lens, aperture and slit mechanisms, photocell, and the drive mechanism. The aperture and slit mechanisms control the camera exposure, and the drive mechanism transports film and rotates the prism. The photocell, located in the lower portion of the body, monitors terrain brightness. It operates, in conjunction with the camera controls, to automatically control film exposure.

b. The magazine (fig. 18-10), which includes the film format area, supplies fresh film to the focal plane, where the film is exposed, and takes up the exposed film. The magazine provides space for the supply spool, takeup spool, film keeper, and pressure roller.

c. The control panel (fig. 18-11) contains the following controls and indicators.

(1) *POWER switch.* When this is ON it applies 115 vac and 28 vdc to internal camera circuitry.

(2) *OPERATE switch.* When this is ON it applies 28 vdc operate voltage to the internal circuitry.

(3) *MODE switch.* This switch has three positions:

(*a*) 2 CPS sequences the camera to take two photographs per second (autocycle mode).

(*b*) 4 CPS sequences the camera to take four photographs per second (autocycle mode).

(*c*) PULSE sequences the camera to take photographs at a rate preset on the intervalometer (pulse mode).

(4) *INTERVALOMETER control knob.* This control can be adjusted manually to sequence the camera to take photographs at a rate of one per second through one every 60 seconds.

(5) *INTERVALOMETER numerical readout.* Indicates the cycle rate of the camera when in the pulse mode.

(6) *EXTRA PICTURE switch.* When you momentarily press the switch it allows the camera to take photographs between cycles (pulse mode).

(7) *FRAMES REMAINING indicator.* This

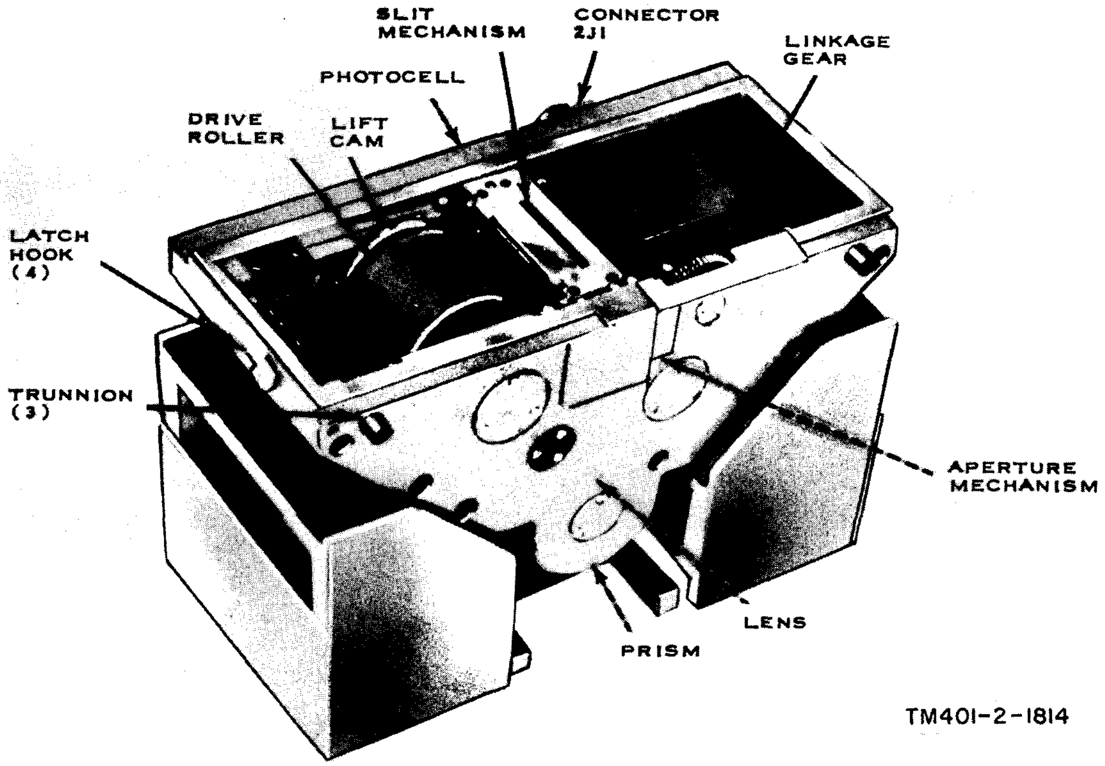


Figure 18-9. Body of the KA-60B.

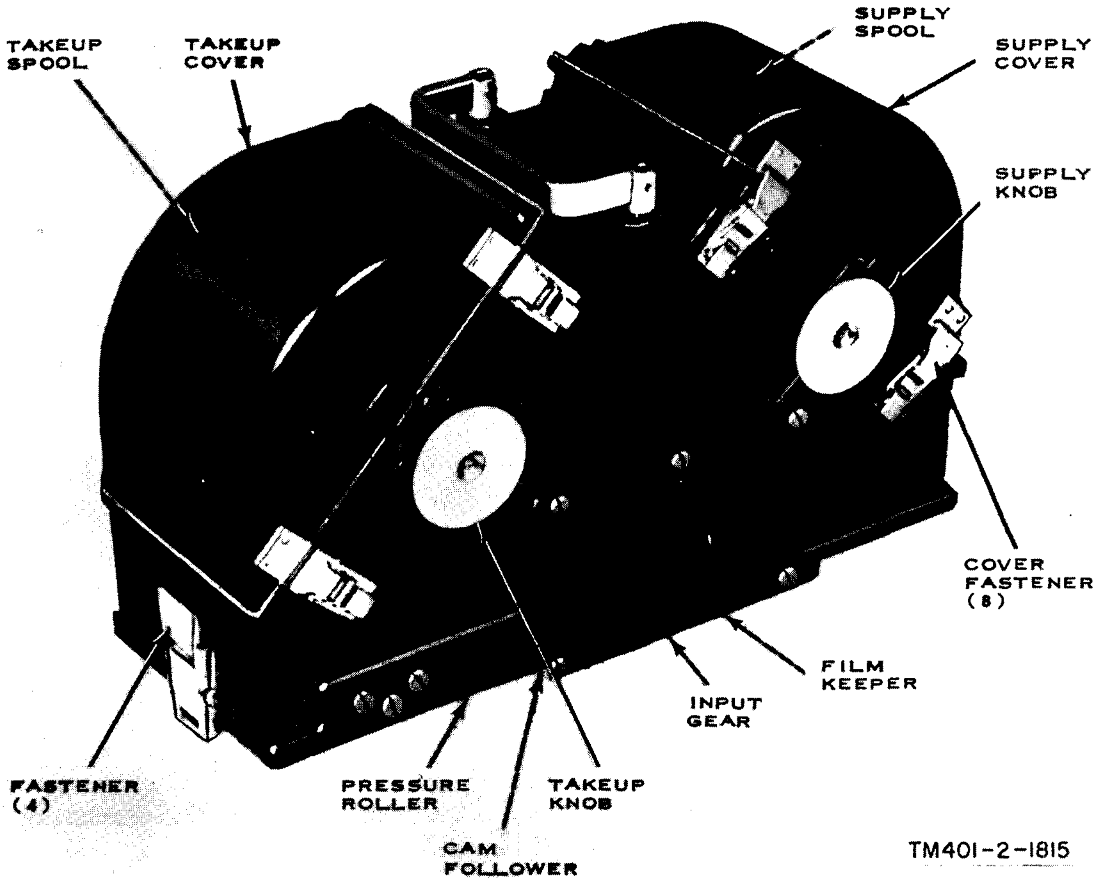


Figure 18–10. Magazine of the KA–60B.

tells you the number of exposures remaining in the camera.

(8) *POWER INDICATOR lamp.* Lights to indicate that +28 vdc is applied.

(9) *OPERATE indicator lamp.* Blinks to indicate that the camera is operating. It remains lit either when the film breaks or when the end of the film is reached.

d. The camera controls box (fig. 18–12) distributes power and operating voltages to other camera components.

18–18. Operating Procedures

Let's assume that you have a photographic assignment and that the camera has been installed in the aircraft. Here are the operating procedures you must perform to carry out your assignment.

a. Preliminary Procedures.

(1) Check to see that all the camera components are installed and interconnected.

(2) Make sure the prism dust cover is removed.

(3) Make sure the magazine has enough film to accomplish the mission.

(4) Make sure the control panel POWER switch and OPERATE switch are OFF.

b. Preflight Operation. After performing all the preliminary procedures—

(1) Operate the POWER switch to ON. The POWER indicator lamp will light.

(2) Turn the INTERVALOMETER control knob until the numerical readout indicates 5 seconds (050).

(3) Set the mode switch to PULSE.

(4) Set the FRAMES REMAINING counter to 000.

NOTE:

Do not allow the procedure in (5) below to last more than 10 seconds.

(5) Set the OPERATE switch at ON. The OPERATE indicator lamp blinks once every 5 seconds to indicate that a photograph is being taken. After two cycles of operation, reset the OPERATE switch to OFF.

(6) Set the mode switch at 2 CPS.

NOTE:

Do not allow the procedure in (7) below to last more than 2 seconds.

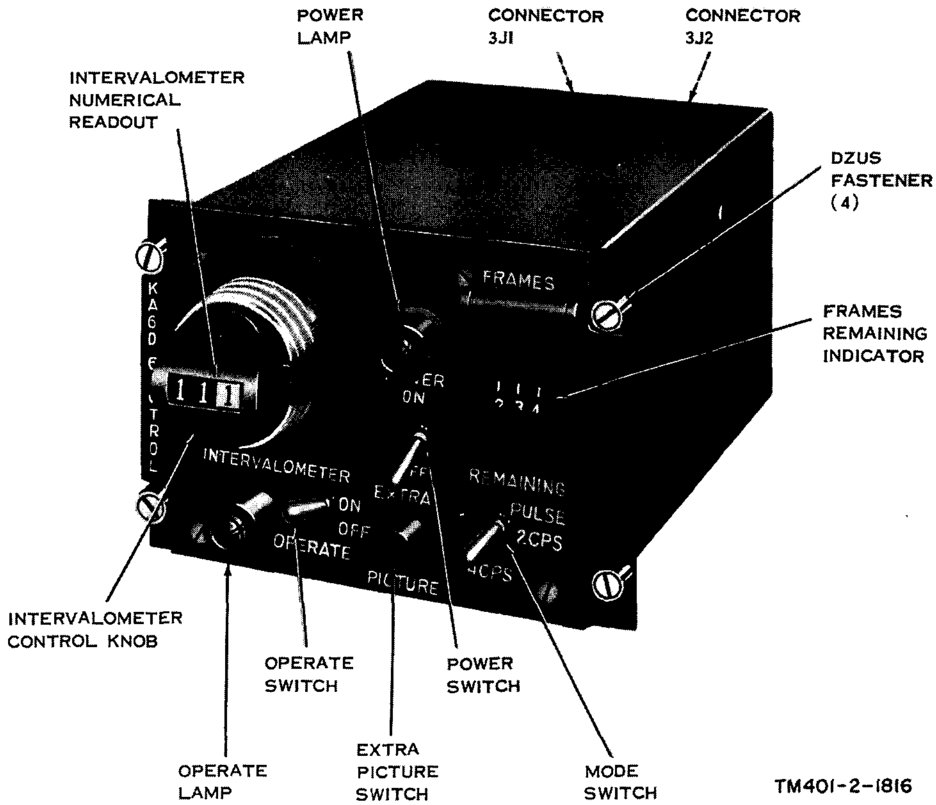


Figure 18-11. Control panel of the KA-60B.

(7) Set the OPERATE switch at ON. The OPERATE indicator lamp blinks twice each second. After four cycles of operation, reset the OPERATE switch to OFF.

(8) Set the mode switch to 4 CPS.

NOTE:

Do not allow the procedure in (9) below to last more than 2 seconds.

(9) Set the OPERATE switch to ON. The OPERATE indicator lamp blinks four times each second. After eight cycles, reset the OPERATE switch to OFF.

(10) Set the POWER switch to OFF.

c. Inflight Operation.

(1) Operate the POWER switch to ON.

(2) Set the mode switch to the desired mode. If you select PULSE, adjust the INTERVALOMETER control knob until the numerical readout indicates the desired camera cycle rate.

(3) When the aircraft is over the target area, set the OPERATE switch to ON.

(4) At the end of a photographic run, set the OPERATE switch to OFF.

NOTE:

If you are going to make more than one photographic run, repeat (3) and (4) for each additional run.

(5) If you need extra photographs, press the EXTRA PICTURE switch.

(6) When you have no more photographic runs to make, set the OPERATE switch and the POWER switch to OFF.

18-19. The KS-61A, a Sophisticated Aerial Camera System

Photographic Surveillance System KS-61A is a complex aerial camera system with many automatic operations. The KS-61A uses Still Picture Camera KA-30A and may be mounted in Army model OV-1A aircraft (Mohawk). A similar system may be mounted in a drone aircraft. The system can be operated at night or in any one of three day modes—PULSE IMC, PULSE, or AUTOCYCLE. Each mode of operation uses the automatic and electromechanical subsystems described in paragraphs 18-20 and 18-21.

18-20. The Day Modes of Operation

a. In the *Pulse IMC* mode, a voltage called the

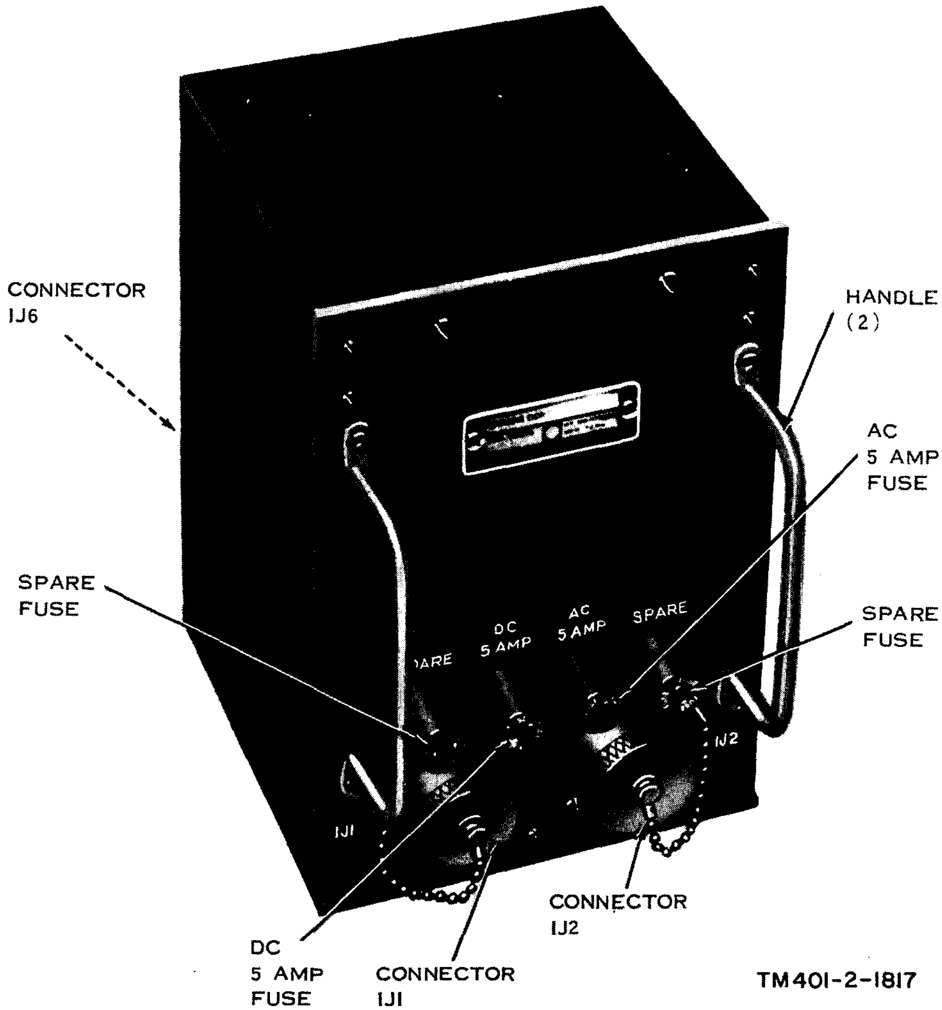


Figure 18-12. Camera controls box of the KA-60B.

V/H ratio, is established either manually by controls in the cockpit or automatically by the Scanner-Scanner Converter. The V/H (velocity/height) ratio voltage is proportional to velocity of the aircraft divided by its height (altitude). The V/H ratio is then modified according to the focal length and depression angle of the camera. The modified V/H ratio voltage is used to drive the film transport system in the camera so that the film moves at the proper IMC speed during the exposure. The modified V/H ratio voltage is also changed to regularly spaced electrical pulses that operate the camera's shutter at the proper time. The Pulse IMC mode is the most commonly used mode of operation.

b. The *PULSE mode* (without IMC) is used at low speeds and high altitudes where the V/H ratio is very small and the voltage developed would not drive the film transport system. Under these conditions the IMC is not necessary, so the film moves only between exposures, and the V/H ratio determines the exposure interval.

c. The *auto remote mode* (AUTOCYCLE) is used at high speeds and low altitudes where the V/H is very high and the exposure interval is very short. In this mode the modified V/H voltage drives the film transport system, and the film transport system operates the camera's shutter when the film is properly positioned.

d. The selection of the mode of operation depends on the camera's focal length, altitude and speed of the aircraft. Selecting the mode, setting the mode, and setting the mode selector switches on both the camera and the Photo Systems Unit must be performed before the flight because neither the camera nor the Photo Systems Unit can be reached during the flight (fig. 18-13).

18-21. The Night Mode of Operation

The night mode is similar to the PULSE IMC mode. The film is driven by the modified V/H voltage for IMC. When the film is in position for

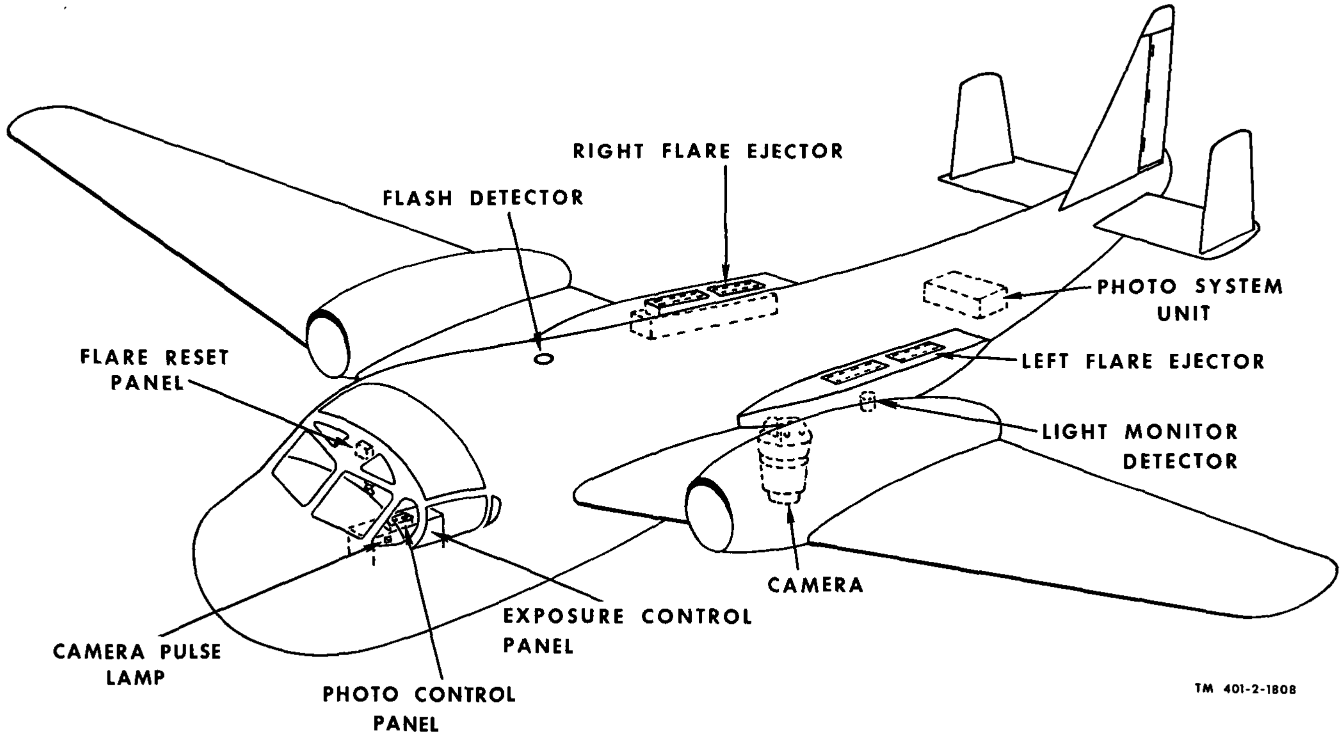


Figure 18–13. KS–61A components location.

an exposure, the camera's shutter opens. The electronic pulse that fires the shutter in the PULSE IMC mode fires a flare instead of the shutter. The flare's light reflected from the terrain exposes the film and activates the photocell of the flash detector. The flash detector produces an electrical pulse that closes the shutter and starts a recycle that positions fresh film for the next exposure.

18–22. Operation of the IMC System

a. The purpose of IMC is to prevent blur on the photographs due to image motion during the exposure. An IMC system moves the film as the image moves.

b. In the Photographic Surveillance System, Airborne KS–61A, the IMC part of the system is used in all modes except the PULSE mode (without IMC). Mode selector switches on both the camera and the photo system unit (fig. 18–14) must be set before the flight because these items are not accessible once the aircraft is airborne.

c. The amount of IMC required depends on the aircraft's altitude and velocity and the camera's focal length and depression angle. An increase in height (altitude) will cause a decrease in image motion. An increase in velocity increases the image motion. An increase in focal length or depression angle is the same as a decrease in height. Of the four required inputs to the IMS system, only the focal length has to be set before the flight. The FOCAL LENGTH switch on the photo system unit is set according to the focal length of the camera. The depression angle of the camera is set by the MOUNT switch on the Photo Control panel in the cockpit (fig. 18–15). The altitude and

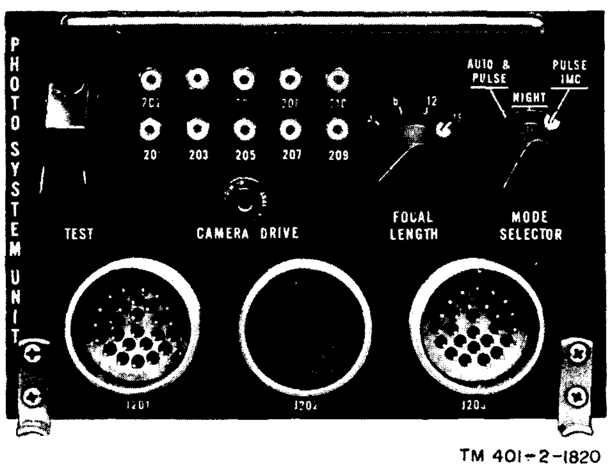


Figure 18–14. Photo system unit.

velocity are set manually on two dials on the Photo Control panel or determined automatically by a device called the Scanner-Scanner Converter.

d. The V/H ratio determined by dial settings on the Photo Control panel or by the Scanner-Scanner Converter is altered in the Photo System Unit according to the setting of the MOUNT and FOCAL LENGTH switches to produce the drive voltage for the film transport mechanism in the camera (fig. 18-15).

18-23. Operation of the Pulse Interval System

a. The Pulse Interval System of the KS-61A generates electrical pulses that operate the camera's shutter mechanism at the correct time in the PULSE mode and the PULSE IMC mode. In the NIGHT mode the electrical pulses fire flares, and a flash detector operates the shutter mechanism. The Pulse Interval System is not used during the AUTOCYCLE mode because the shutter mechanism is operated by a signal from the camera's film transport mechanism.

b. The pulse interval is determined by three of the same factors that determine IMC—height, velocity, and focal length. Depression angle does not affect the pulse interval. When you set the controls for IMC, you are also setting them for the pulse interval.

c. The system is put into operation by turning on the POWER switch and operating one of the OPERATE switches (fig. 18-16). A voltage proportional to the V/H ratio is applied to the Photo System Unit from either the Photo Control panel or the Scanner-Scanner Converter. The Photo System Unit modifies the V/H ratio voltage according to the setting of the FOCAL LENGTH switch to produce the electrical pulses that either operate the shutter or fire flares.

d. Just before a pulse is applied to the shutter, an advance pulse lights the CAMERA PULSE lamp in the cockpit. This warns the pilot and the observer that an exposure is about to be made.

e. Each time the shutter operates, a count is subtracted (automatically) from the EXPOSURES REMAINING counter on the Photo Control panel.

f. The pulse applied to the flare ejector also subtracts a count from the FLARES REMAINING counter on the Photo Control panel.

g. The CAMERA PULSE (extra picture) switch is used to override the system and produce an exposure at the discretion of either the pilot or the observer.

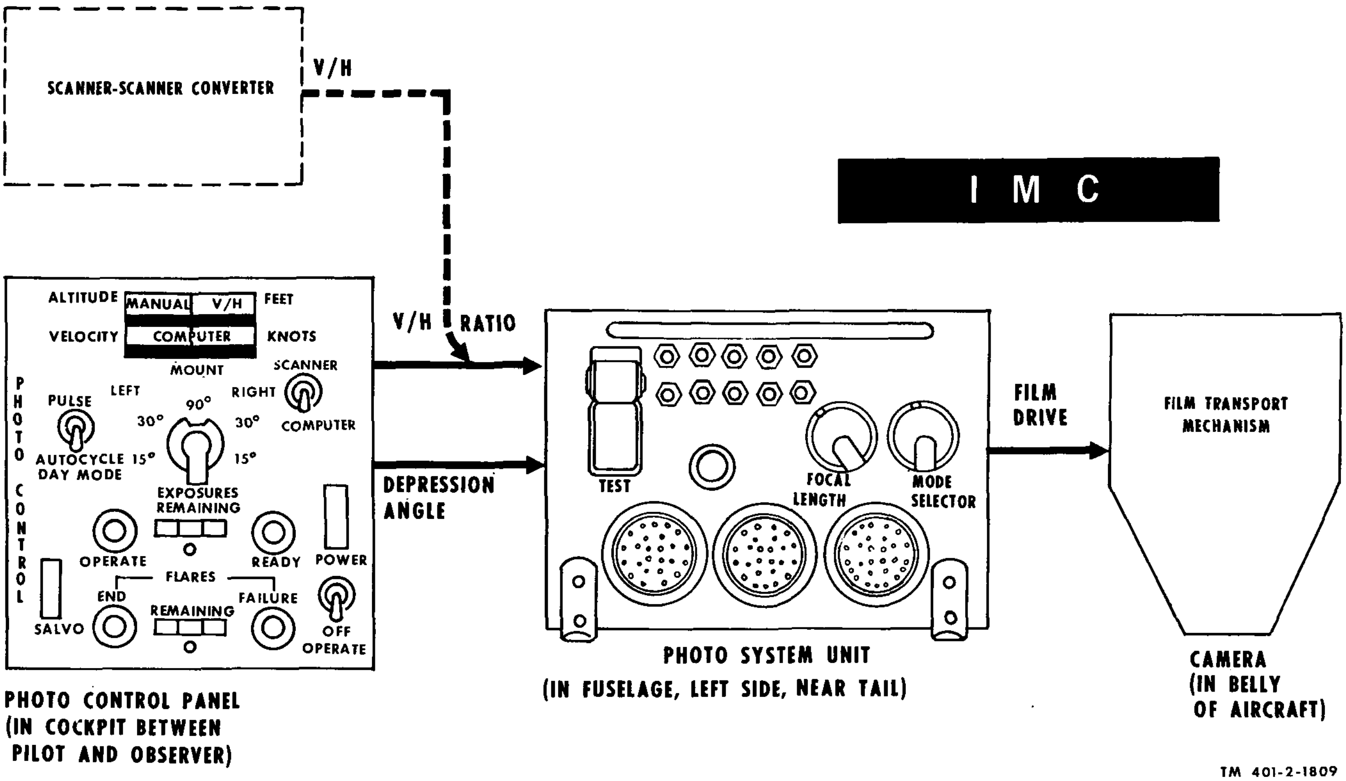


Figure 18-15. The IMC system.

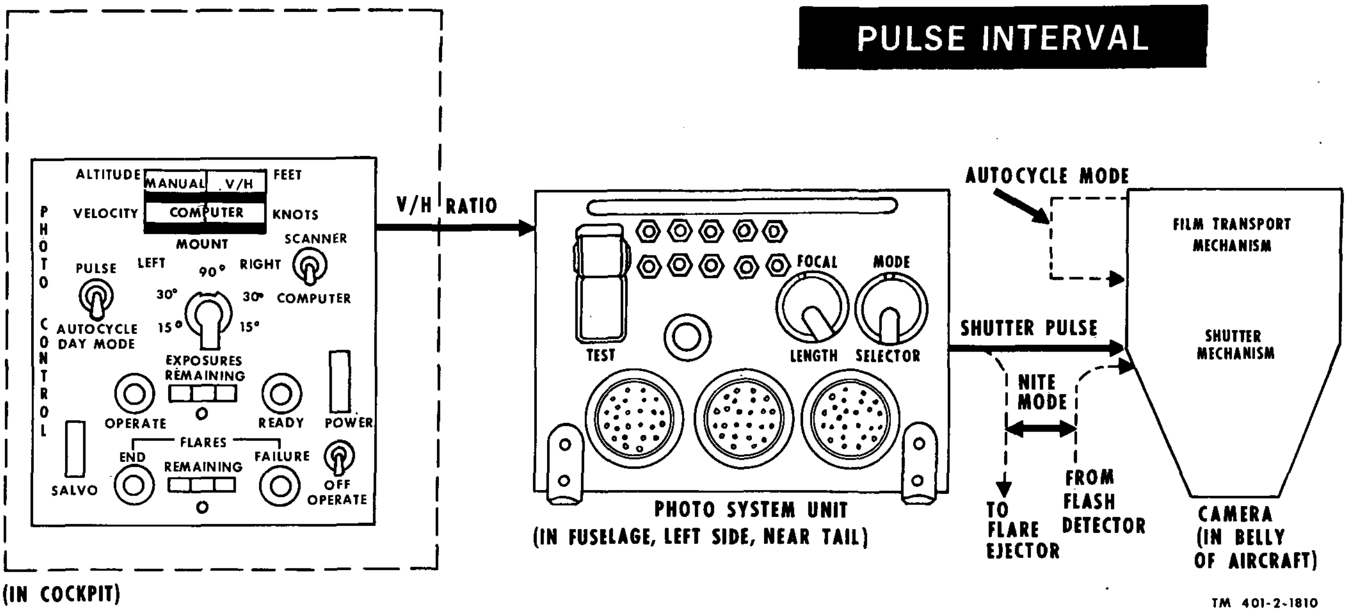


Figure 18–16. Pulse interval system.

18–24. Operation of Exposure Control System

a. The exposure control system of Photographic Surveillance Systems Airborne KS–61A measures the terrain brightness, sets the diaphragm opening, and adjusts the shutter speed. The diaphragm opening and shutter speed are also controlled by the setting of the S/C dial on the camera. The S/C dial is set before the flight according to the film speed and filter factor.

b. During the photographic run the photocell in the Light Monitor Detector measures the terrain brightness and sends an electric current to an exposure meter on the Exposure Control panel (fig. 18–17). The exposure meter dial is calibrated in f-stops, over and under normal, to provide a more flexible system. Usually the LIGHT switch is adjusted for a NORMAL reading on the exposure meter. Setting the LIGHT switch selects an ex-

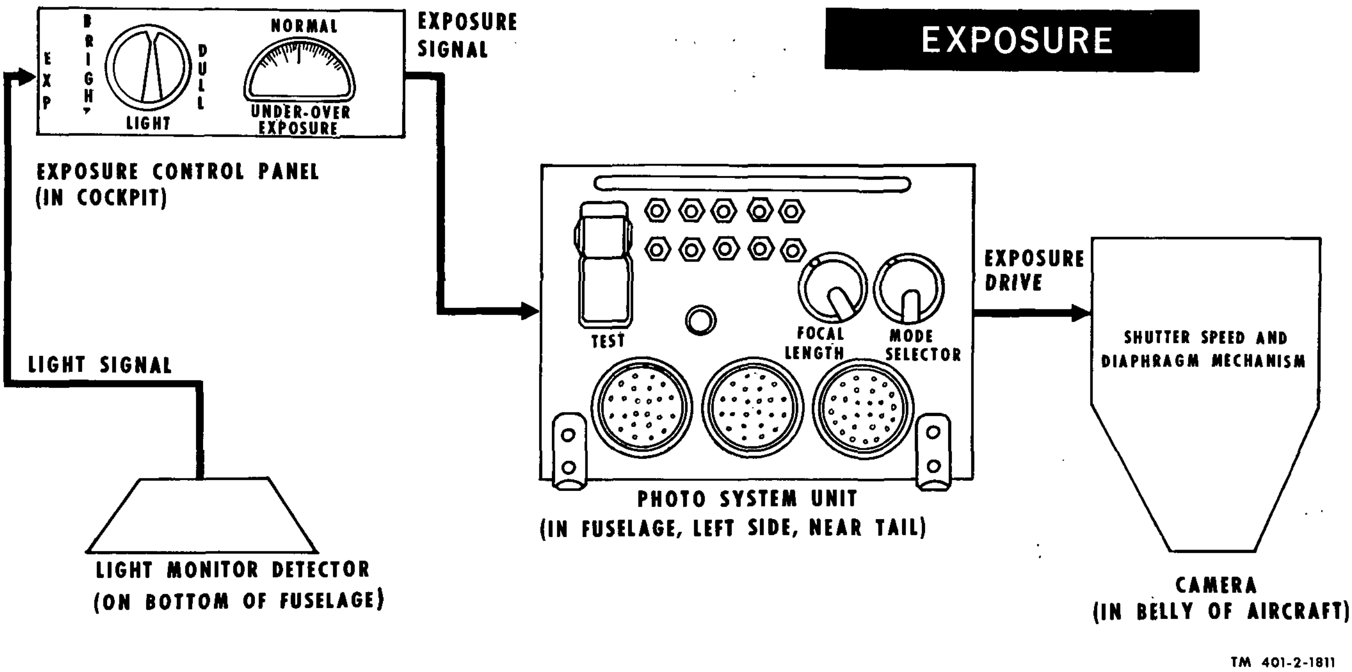


Figure 18–17. Exposure control system.

posure signal that is sent to the Photo System Unit.

c. In the photo system unit the exposure signal from the Exposure Control panel is compared with the actual diaphragm opening and shutter speed. If a discrepancy exists, a drive voltage is applied to the shutter speed and a diaphragm mechanism in the camera to adjust the amount of exposure.

18-25. Flare Ejection and Flash Detection

a. During the NIGHT mode the shutter is normally open. It is closed for recycle upon the burst of a flare. The exposure rate equals the flare ejection rate, which is controlled by the pulse interval system.

b. Timed pulses from the photo system unit cause the flares to be ejected and also subtract one count from the FLARES REMAINING counter on the Photo Control panel (fig. 18-18). Flares are ejected up and toward the rear so that the light of the flare does not shine directly into the camera. Approximately 2 seconds (depending on the type of flare) after the flare is ejected it bursts. The light of the burst is seen by a photocell in the Flash Detector, which is located in either the left wing pod or on top of the aircraft. Upon detecting the burst, the Flash Detector operates the shutter mechanism.

c. The 52 flares of the left ejector are fired first. Then the timed pulses are passed through the left flare ejector and transferred to the right flare ejector to fire 52 more flares. After the last flare is ejected the FLARES END lamp on the Photo Control panel will light.

d. The sequence in which the flares are ejected is determined by switches in the flare ejectors. At the beginning of a flight these switches must be reset to their starting positions. Resetting is performed by holding both RESET switches on the Flare Reset panel to the RESET position until the RESET indicator lamps light.

e. You may not always need to use the total capacity of 104 flares, so load only the number of flares you require for the mission. The aircraft should not land carrying flares, and all excess flares must be ejected after the mission. In an emergency or at the end of a mission, operating the SALVO switch on the Photo Control panel will rapidly eject the flares in both the left and right ejectors at the same time. All 104 flares can be salvoed in less than 10 seconds.

18-26. Oblique Photography With the KS-61A

a. The camera is mounted in a motorized mount inside the aircraft. The mount moves so that the camera is positioned to take high or low left obliques through the left camera window, verticals through the vertical camera window, and high or low right obliques through the right camera window.

b. During the flight the MOUNT switch on the Photo Control panel is set to LEFT 15° for a left high oblique, LEFT 30° for a left low oblique, 90° for vertical, RIGHT 30° for right low oblique, and RIGHT 15° for right high oblique. The cam-

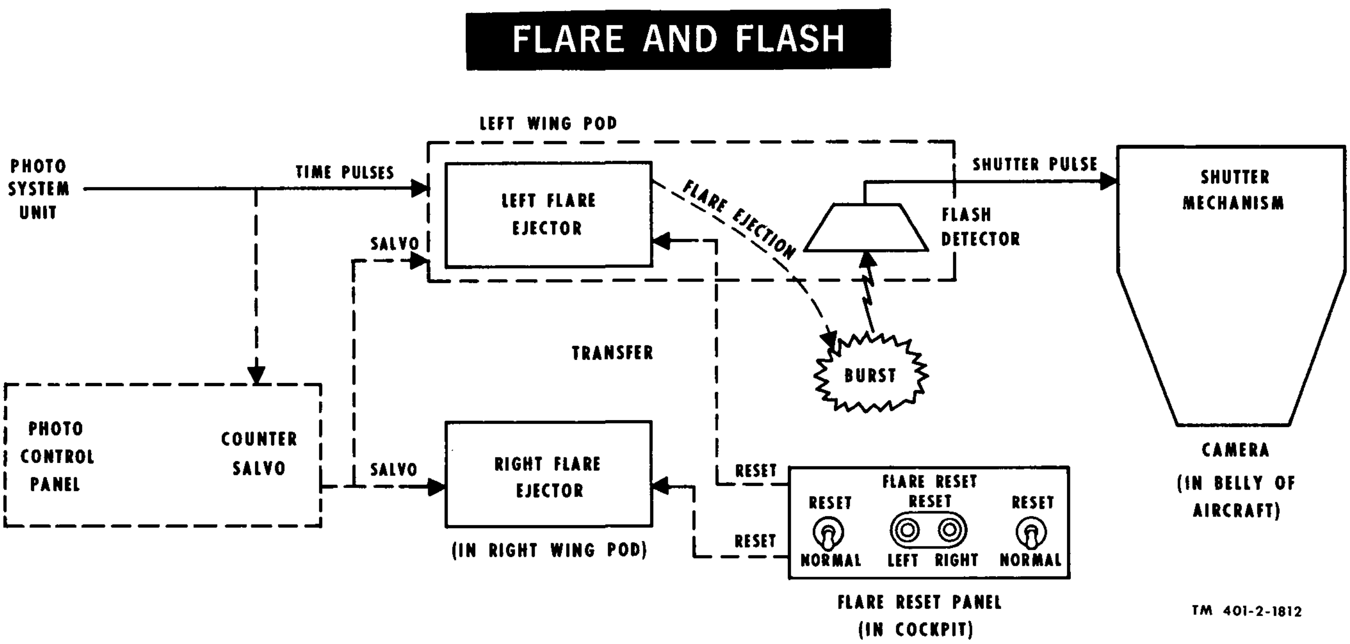


Figure 18-18. Flare and flash operation.

era depression angle can be changed during the mission.

c. The three camera windows are protected from dirt and scratches by covers called doors. When you apply power to the camera system via the POWER switch on the Photo Control panel, the proper door will open according to the setting of the MOUNT switch. An open door will automatically close when the MOUNT switch is set to a new position that requires a different door to open or when the power is turned off.

18–27. The KS–61A Camera

a. The KS–61A uses Still Picture Camera KA–30A, which includes the 6-inch Aerial Camera Lens Cone LA–131A (fig. 18–19). Figure 18–20 shows the camera body and lens cone separated and positioned to show the location of the mode selector switch and the S/C control. The lens cone is interchangeable with the 3-inch Aerial Camera Lens Cone LA–130A.

b. The camera uses aerial roll film that is 5 inches wide and 100 feet long. Two-hundred-forty exposures, each 4.5 inches by 4.5 inches, can be made on a full roll of film.

c. The 6-inch lens cone LA–131A has a focal length of 6 inches. The exposure is continuously variable between 1/150 and 1/400 second at f/2.8 to f/16.

d. The 3-inch lens cone LA–130A has a focal length of 3 inches. Its exposure is continuously variable between 1/150 and 1/800 second at f/4.5 to f/11.

e. A yellow and a red filter are included with each lens cone.

f. Operation and maintenance of the camera are discussed in TM's 11–6720–208–12 and –35.

18–28. Flasher System, Photographic, Aircraft LS–59A

a. General. The LS–59A provides high intensity, short duration flashes of light. It is used in conjunction with Photographic Surveillance System, Airborne KS–61A to provide illumination of terrain beneath the aircraft for reconnaissance photography at night. The LS–59A is installed on Army models OV–1, OV–1A, and OV-1C Aircraft (Mohawk).

b. Parts of System. The LS–59A is made up of a pod assembly (fig. 18–21), a pilot's control panel (fig. 18–22), and other minor components.

(1) *Pod assembly.* The pod assembly contains the major operating parts of the electronic flash system. It houses the turbine-alternator, which develops the power required for operation of the flash equipment. It also contains three illuminator modules, each one containing four xenon flashlamps, a parabolic reflector, storage capacitors, connectors, and mounting facilities. Also in the pod assembly are the power supply module and the logic module, which programs the firing sequence of the illuminator modules.

(2) *Pilot's control panel.* The pilot's control panel interconnects the photo control system and the electronic flash system and starts and stops the flash equipment. It has a POWER switch, an OPERATE indicator lamp, and a panel illuminating lamp.

c. How the LS–59A Works.

(1) The LS–59A electronic flash system is triggered automatically by the camera. The amount of illumination depends on the E V/H (ratio of groundspeed (V) and altitude (H) to voltage (E)) signal from the photo system. The flash fires at the same rate and in sequence with camera frame pulses from the photo control system. The camera frame pulses trigger the flash so that maximum illumination occurs when the camera shutter is fully open.

(2) The three separate illuminator modules can provide a variable amount of illumination because the circuits in the logic module can program the modules so that they fire one at a time, two at a time, or all three simultaneously. The amount of illumination needed depends on aircraft speed and altitude. At low altitude, when minimum illumination is required, the illuminator modules fire sequentially. At medium altitude the modules fire in pairs, and at high altitude the three modules fire simultaneously.

(3) TM 11–6760–228–12 provides detailed information on how the LS–59A functions.

18–29. Camera, Still Picture KA–76A

a. General Information.

(1) The KA–76A (fig. 18–23) is a compact, high acuity, aerial reconnaissance, serial frame camera that can take exposures during day or night. The camera has image motion compensation (IMC) so that it can operate at lower aircraft terrain clearances and higher groundspeeds than it could without IMC. Lens Cones, Camera, Aerial Reconnaissance LA–370A and LA–371A provide a wider angle of view when greater terrain coverage is needed. Lens Cone, Camera, Aerial Reconnaissance LA–372A provides a smaller angle of view with image magnification.

(2) TM–6720–236–12 provides detailed information on how the KA–76A works and how you operate it. A general description of the KA–76A is given in *b* and *c* below.

b. Modes of Operation. The KA–76A can be

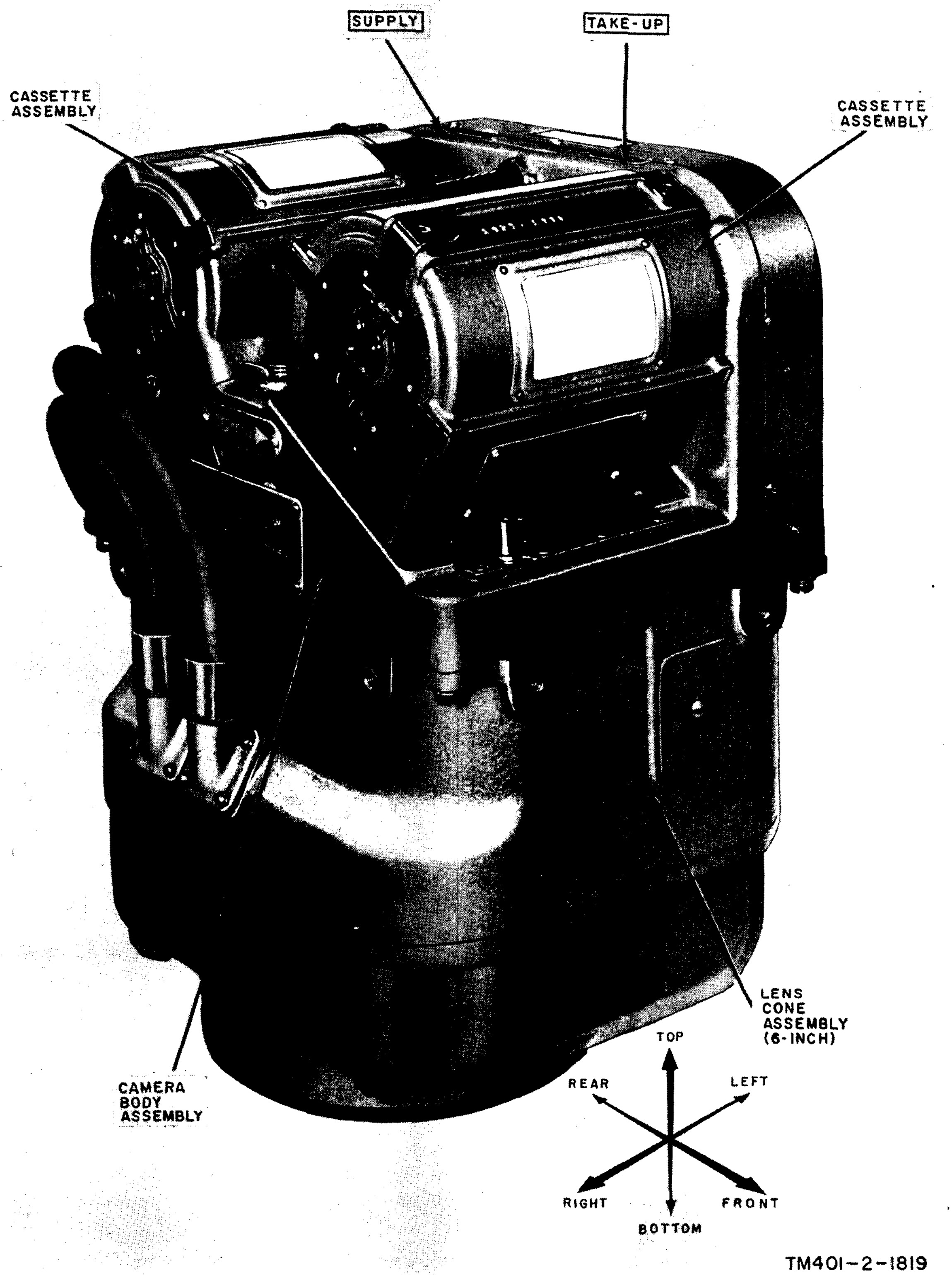


Figure 18-19. Still Picture Camera KA-30A.

used for either vertical or oblique aerial photography using one of three daylight and two night modes. You can select four of the modes remotely by using the aircraft photographic control system (APCS).

(1) *Autocycle.* The control equipment scans the terrain for reflected light and forward motion. It automatically sets the camera for the correct

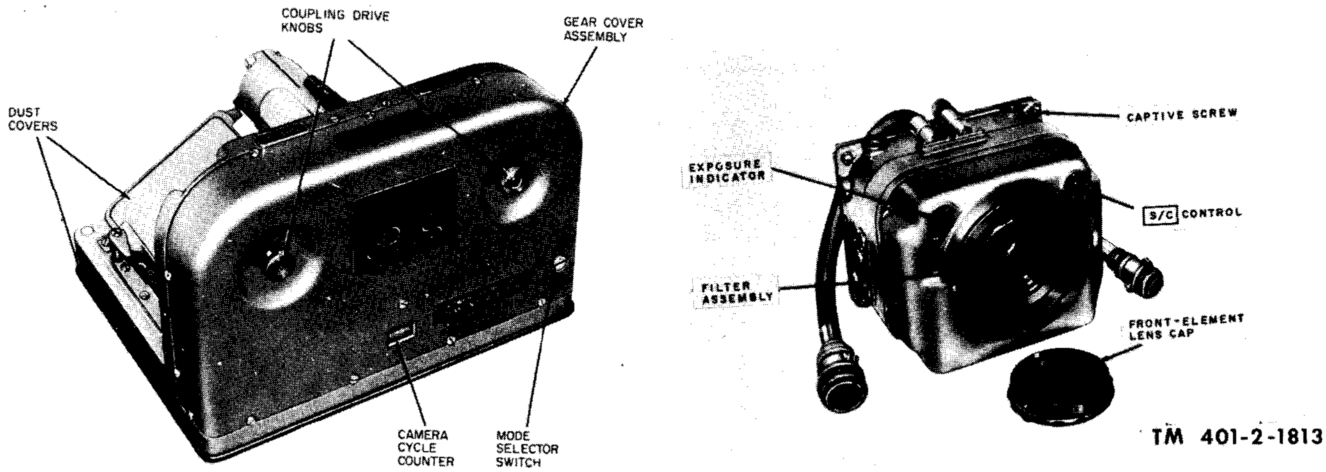


Figure 18-20. Location of mode switch and S/C control.

exposure, IMC, and exposure interval to produce 60 percent overlap between frames. The film moves continuously.

(2) *Pulse.* An exposure is made each time a cycle pulse is received from the APCS. The pulse rate is set into the intervalometer in the APCS. Control equipment scans the terrain for reflected light and automatically sets the camera for the correct exposure. There is no IMC in the pulse mode. The film is stationary between each camera cycle.

(3) *IMC pulse.* The camera operation is the same as in the pulse mode except that IMC is used.

(4) *Night electronic flash.* This mode operates the same as the autocycle mode with the following addition: A switch in the shutter triggers electronic circuits in the APCS to produce synchronized flash illumination. Exposures are made at the slowest shutter speed and the largest lens aperture.

(5) *Night open shutter.* This mode is not normally used. The shutter opens before the exposure. A signal from the APCS intervalometer causes a flash cartridge to be ejected. The control equipment detects the flash, the shutter closes, the camera recycles, and then the shutter opens in preparation for the next flash. Exposures are made at the slowest shutter speed and largest aperture. IMC is used.

c. Parts and Technical Characteristics of the KA-76A.

(1) The KA-76A consists of the camera body, shutter assembly, two cassettes, and a lens cone. The LA-374A, a 6-inch lens cone, comes with the KA-76A. The following three lens cones of different focal lengths are available as accessories:

LA-370A—1¾-inch lens cone

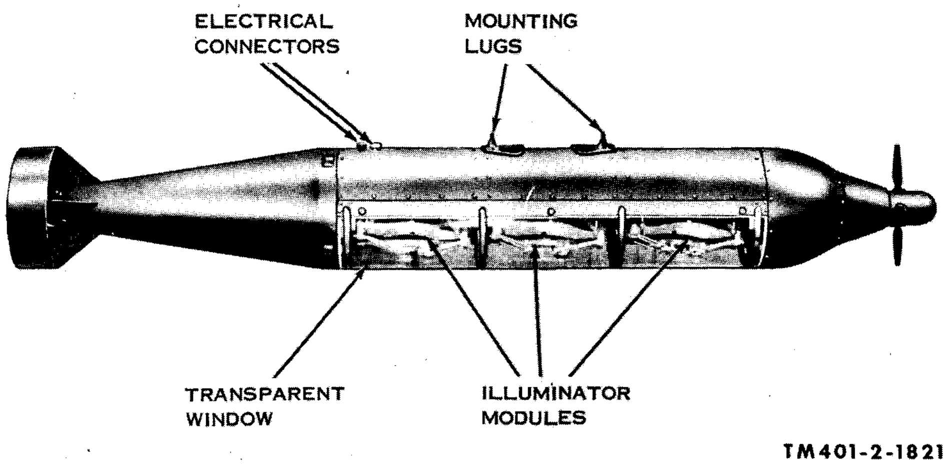


Figure 18-21. Pod assembly of the LS-59A.

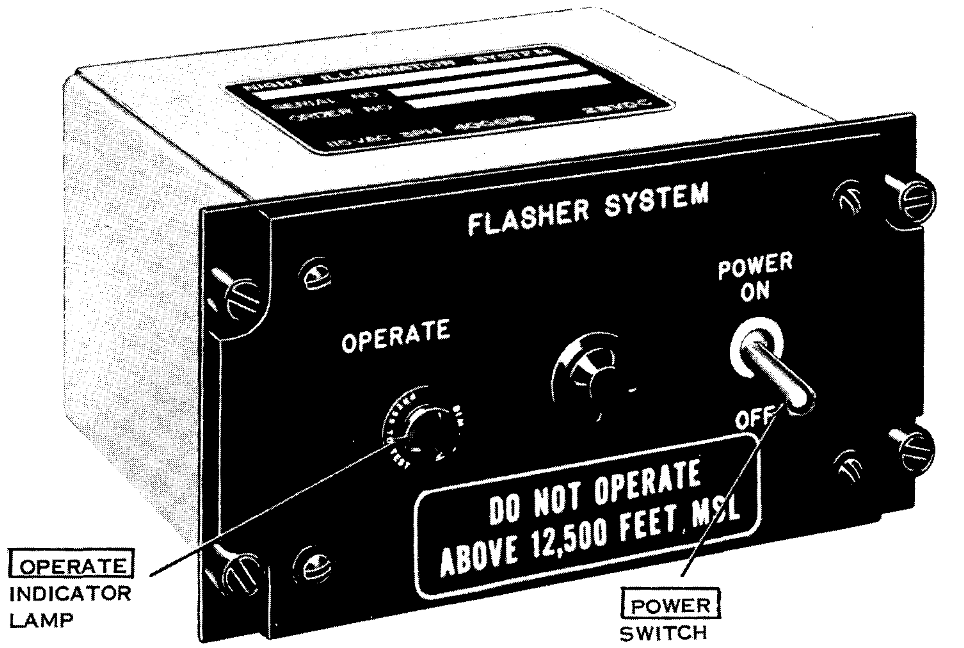


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Figure 18-22. Pilot's control panel for the LS-59A.

LA-371A—3-inch lens cone
LA-372A—12-inch lens cone

The 3- and 12-inch lens cones are provided with a yellow lens filter and a red lens filter. The 1¾-inch lens cone has a yellow filter only.

(2) The KA-76A uses aerial roll film, either black and white or color. The film format is 4.5 inches by 4.5 inches and is 250 feet long. There is a maximum of 600 exposures per roll.

18-30. How the KA-76A Compensates for Altitude and Groundspeed

a. During exposure the film is driven across the platen at a speed determined by a signal from an exterior source. In the automatic condition, a scanner senses terrain movement and feeds a signal to a converter. The converter changes this to a dc signal, which determines the speed of the film drive motor. Thus, the film is always stationary with respect to the image. In the manual condition, the computer speed and altitude are set into a computer that produces a dc drive voltage proportional to the settings. The image and film will be stationary with respect to each other if the computed speed and altitude are accurate.

b. In the automatic mode, a portion of the signal from the scanner is used to vary the basic frequency at which the camera is tripped so that the percent of overlap remains constant despite changes in altitude or groundspeed. In the manual mode, the computer signal is used to determine the exact frequency at which the camera is tripped.

c. When automatic exposure control (AEC) is used, a light sensor observes the light reflected from the terrain and produces a signal proportional to the amount of light. This signal is fed to the exposure control circuits in the camera to either increase or decrease the exposure. A manual override in the cockpit can vary the exposure by one f-stop either way. If no light sensor is used, shutter speed and lens opening must be set manually before the mission.

18-31. Operational Procedures

Before each mission you will have to select the lens cone, film, and filter, and you will have to make certain inspections and settings.

a. Selecting lens, film, and filter. In selecting a lens cone you will have to consider the area to be covered, the desired scale, and the aircraft altitude and speed. When you select the film you'll have to keep in mind the available light and the type of target. Choose the film with the highest resolving power for the existing conditions. The filter should fit the existing atmospheric conditions.

b. Settings.

(1) *Shutter speed and aperture.* If AEC is not available, you will have to set the shutter speed and aperture before the mission. At best

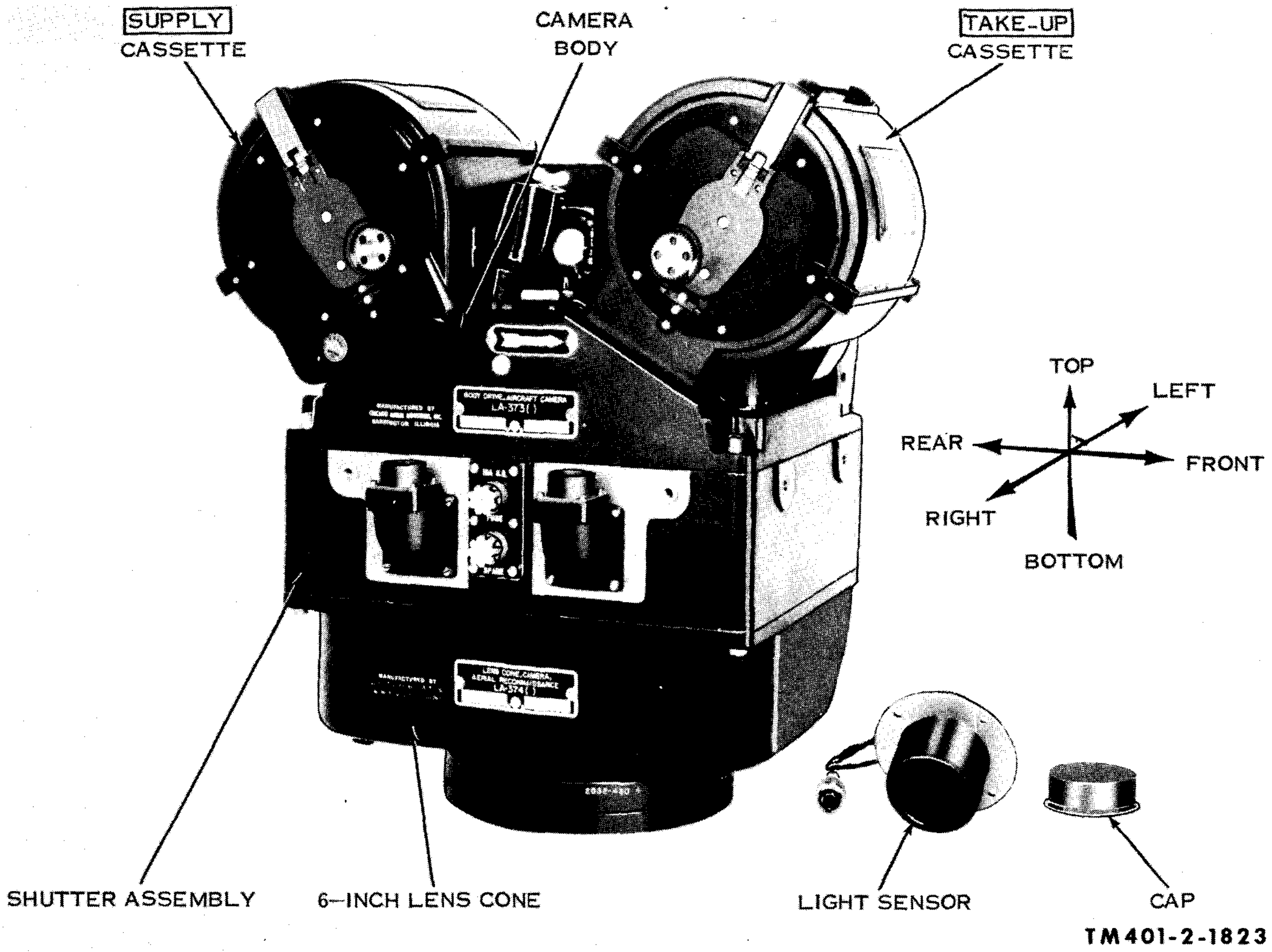

Figure 18–23. Camera, Still Picture KA–76A.

you'll only be able to approximate what the aerial conditions may be.

(2) *Mode selector switch.* The mode selector switch in the camera body permits operation of the camera with either a limited APCS or an APCS that includes a remote control mode switch. If the camera will be operated with a limited APCS, then you will have to set the mode selector switch in the camera body during preflight procedures.

c. Preoperational inspection. Before each mission, check the equipment as follows:

(1) Check to make sure the equipment is complete.

(2) Inspect each component for moisture, mildew, fungi, or corrosion.

(3) Inspect glass for moisture, scratches, or fingerprints.

(4) Be sure the front cap has been removed. If you're using a filter, make sure it is securely mounted on the front lens assembly.

18–32. Inflight Operation

These procedures are general, since the particular type of APCS to be used for the mission is not known.

a. Five minutes before beginning the photographic runs, turn the ready power ON to allow the equipment to warm up.

b. Set the system control box for the mode of operation to be used (remote control only).

c. Set the V/H computer in the control system for the speed and altitude of the aircraft during the photographic runs. (This setting is necessary only during manual operation when a mode using IMC has been selected.)

d. At the beginning of each photographic run, apply operating power to the system.

e. At the completion of each run or when the film is used up, turn off the camera operating power.

f. At the end of the mission, turn off the ready power to the camera system.

18-33. Summary

a. Still Picture Cameras KA-23A and KA-24A are connected to Camera Control Group LS-13A for automatic operation.

b. Camera Control Group LS-13A includes an intervalometer for determining the exposure rate, a control box as a junction point, and two indicator lamps to indicate that the system is operating and to give advance warning of the time of an exposure.

c. Still Picture Camera KA-20A is a simple automatic aerial camera for vertical, daylight photography.

d. Still Picture Camera KA-39A is an automatic aerial camera for vertical, day or night photography.

e. Photographic Surveillance System Airborne KS-61A is an automatic, vertical and oblique, day and night aerial camera system. Flasher System, Photographic, Aircraft LS-59A is used in conjunction with the KS-61A to provide lighting for reconnaissance photography at night.

f. Photographic Surveillance System Airborne KS-61A has four modes of operation—Pulse, IMC Pulse, Autocycle, and Night.

g. Still Picture Camera KA-30A is used with the KS-61A.

h. Before a flight you must check the equipment, load the film, mark the data plate, install the filter, set controls that require presetting, install the camera, install flares if necessary, and check the system's operation.

i. During the flight you help the pilot locate and line up the target, operate the manual controls (if any), oversee the photographic operation, and keep notes to fill out the captions.

j. After the flight you remove the camera, initiate film processing, and complete the captions.

k. IMC stands for image motion compensation and refers to a procedure that prevents blur due to camera motion during exposure.

l. More IMC is needed for faster aircraft speeds, lower aircraft altitudes, longer focal length lenses, and greater camera depression angles.

m. The altitude adjustments on the Still Picture Cameras KA-20A and KA-39A are set before the flight to control both IMC and exposure rate.

n. The IMC of the KS-61A can be adjusted in flight by either a Scanner-Scanner Converter or manual controls in the cockpit.

o. The Pulse Interval System of the KS-61A uses the same three factors of height, velocity, and focal length as the IMC system.

p. On Still Picture Cameras KA-20A and KA-39A you determine the amount of exposure by setting the shutter speed control knob and by choosing the filter.

q. The KS-61A includes an exposure control system that can vary the amount of exposure in flight from 1/150 second at f/2.8 to 1/400 second at f/16 when the 6-inch lens cone is used.

r. Camera, Still Picture KA-76A is a high acuity, aerial reconnaissance, serial frame camera that can take exposures day or night. It has IMC and three daylight and two night modes.

s. Camera, Still Picture KA-60B is a moving film panoramic aerial camera that provides horizon-to-horizon reconnaissance capability.

18-34. Review Questions

a. What should be the setting of the altitude adjustment of Still Picture Camera KA-20A if the aircraft will fly at an altitude of 1,000 feet and a groundspeed of 100 miles per hour?

b. What shutter speed setting and what filter should be used on Still Picture Camera KA-20A for average terrain brightness?

c. What should be the groundspeed of the aircraft if the plane is flying at 1,500 feet and the altitude adjustment of Still Picture Camera KA-39A is set at 2 on the 200 MPH range?

d. What shutter speed setting and what filter should be used for night operation of Still Picture Camera KA-39A?

e. What is the function of the SALVO switch?

f. Which modes of Photographic Surveillance System Airborne KS-61A use IMC?

g. In the term "V/H ratio," what do the letters V and H stand for?

18-35. Answers to Review Questions

a. 2,000.

b. 1/150, either yellow or red.

c. 150 miles per hour.

d. 1/150, clear.

e. The SALVO switch is used to quickly eject all the flares in emergencies.

f. IMC Pulse, Autocycle (Auto Remote), Night (NITE).

g. Velocity, height (altitude).

APPENDIX A

REFERENCES

1. Army Regulation

AR 108-5	Still and Motion Picture Photography.

2. DA Pamphlets

DA Pam 108-1	Index of Army Motion Pictures and Audio-Visual Aids.
DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.

3. Technical Manuals

TM 11-401-1	Army Pictorial Techniques, Equipments, and Systems: Pictorial Fundamentals.
(O) TM 750-5-5	Photographic Equipment Data Sheets.

4. Field Manuals

FM 11-40	Signal Corps Pictorial Operations.
FM 21-26	Map Reading.

APPENDIX B

GLOSSARY

Absorption curve—A chart that shows the effect of a filter over a range of colors.

Additive color film process—A color process in which the colors seen are a result of the addition of colored light from the three primary colors. The process is used infrequently, the subtractive process being more common.

Angle of depression—The angle between the camera axis (optical axis) and the horizontal in oblique aerial photography.

Angle of field—The angle between imaginary lines that connect opposite sides of the area of usable illumination to the optical center of the lens.

Background light—A light projected on the background behind the subject, generally used in portrait photography.

Back light—Any light that shines from behind the subject toward the camera. It separates the subject from the background and causes a three-dimensional effect because it forms a partial or complete rim of light on the subject.

Bounce flash—A lighting technique used in flash work in which the light source is not aimed directly at the subject but is directed at the ceiling or wall and bounced back to the subject for an indirect type of light with indistinct shadows. It is preferred when a more natural look is desired in the subject.

Center of interest—The point in a picture containing the principal subject or action.

Circle of illumination—The total image area of a lens, only part of which is actually used in taking a picture.

Color correction filters—Filters that absorb various amounts of specific colors. Used principally for copying or printing.

Color temperature—A scale used in color photography to describe the apparent color of a light source in terms of its relative blue or red content. Expressed in degrees Kelvin or in decamireds.

Complimentary colors—Two colors of light that combine to produce white.

Composition—The arrangement of parts or objects in a picture to form a pleasing and harmonious whole.

Continuous-tone original—In copy photography, an original with more than two tones, various shades of gray, or color.

Crab angle—The angle between the axis of the photograph in the direction of the flight and the flight line.

Crabbing—The sideward motion of an aircraft as it moves forward.

Decamired—A unit for measuring the color of light. The decamired value equals 100,000 divided by the Kelvin color temperature value.

Depth of field—The distance from the nearest point in focus in the focal plane to the farthest point in focus.

Diffusion transfer reversal method—The polaroid process of image formation. Soluble silver halide *diffuses* across a thin layer of reagent and is *transferred* to the positive plate. The silver precipitates as a black metallic substance, thus *reversing* the image.

Distortion—Image displacement caused by lens irregularities and aberrations.

Electronic flash—A high-intensity, short duration flash used as a source of illumination.

Exploded view—A photograph showing objects disassembled but in proper order of assembly.

Fill-in light—A second light used to lighten shadows that are caused by a main or key light.

Final caption—A photograph caption, prepared by the processing lab, that appears on the back of each print distributed and on the jacket of each record negative.

Fisheye lens—A super wide angle lens with an angle of view of 180°. It sees both sides, up and down, and forward all at the same time.

Focal point—A point on the focal plane where converging rays of light from a lens meet.

Ground gain forward—The distance the camera moves between overlapping aerial exposures.

Ground gain sideways—The amount of new ground covered laterally by successive aerial photographic runs over an area.

Guide number—A numerical rating given to a flashlamp to indicate its strength and to aid in determining exposure.

High oblique—An aerial photograph taken looking out and down from the aircraft at an angle that includes the horizon and is more a side view than an overhead view.

Horizontal—An aerial photograph taken with the camera looking straight out from a low flying aircraft.

Hypersensitizing—Increasing the speed of film by chemically treating it.

Hyperstereoscopy—An exaggerated stereo effect where the apparent depth is increased. For instance, hills appear steeper and depressions deeper than they really are.

Image motion compensation—Moving the film during an exposure to keep the image focused on the same spot on the film to prevent blurring the image.

Intensity—The brightness of a light source.

Interval—The time lapse between exposures. In aerial photography this is equal to the ground gain forward divided by the groundspeed of the aircraft.

Intervalometer—An automatic timing device for regulating aerial camera exposures; it may cock and trip the shutter automatically.

Inverted stereo—The effect of interchanging the position of stereo pictures so that hills look like valleys and valleys look like hills. Also called **pseudo stereo** and **reverse stereo.**

Kelvin temperature scale—An absolute temperature scale that describes the color distribution of light. Kelvin (K) equals centigrade temperature (C) plus 273°: $K=C+273$. $K=5/9$ (Fahrenheit temperature $+32$) $+273$.

Lens coating—A thin transparent coating applied to the surface of a lens element to reduce reflection.

Lighting ratio—The ratio of the illumination of highlights to the illumination of shadows.

Line original—In copy photography, an original with only two tones, one light and one dark.

Low oblique—An aerial photograph taken looking down and out from the aircraft at an angle that does not include the horizon.

Macrophotography—Making photographs in which the image is up to 10 times larger than the object.

Main light—The main source of illumination when lighting with two or more light sources. It is also called the **key light** or **modeling light.**

Master caption—One caption that gives information common to a series of pictures.

Military Grid Reference System—The grid system used in the military to locate places on a map. It is a combination of the Mercator and Polar grid systems.

Mosaic—Several aerial strips pieced together to form one large composite picture.

Oblique—An aerial photograph taken with the camera axis directed between the horizontal and vertical planes.

Orthochromatic film—A type of film that is sensitive to ultraviolet, blue, green, and some yellow light but not to red.

Overlap—The amount of the same scene that appears on two photographs for stereos, strips, and mosaics.

Panchromatic film—A black and white emulsion that is sensitive to all visible light. It is the most widely used film emulsion because it most nearly approximates the sensitivity of the human eye and because it generally has the highest film speed.

Panning—Moving the camera in step with a moving object so that the object appears to stand still while the background is blurred.

Panoramic—A picture shown one part at a time by being unrolled before the observer, or a complete view of an area in every direction. There are two types, swing and moving.

Parallax—The viewing difference of an object as seen through the viewfinder and as actually photographed by the taking lens. This fault will result in improper framing (heads chopped off, objects not in center of the photograph) if not compensated for with a parallax footage adjustment.

Perspective—The illusion of three dimensions on a flat surface.

Photoflash cartridge—A pyrotechnic cartridge designed to produce a brief and intense illumination for low altitude night photography.

Photographic scale—The ratio of a distance measured on a map or photograph to the corresponding distance on the ground.

Photomicrography—Photographing extremely small objects through a microscope.

Pinpoint—An aerial photograph of a target small enough to be included in one exposure.

Polarized light—Light that vibrates in only one direction.

Primary colors—The three components of white light—blue, green, and red.

Saturation—Degree of purity of color or freedom from dilution by white, black, or gray. A highly saturated color has no gray, and an unsaturated color contains gray.

Scale—Ratio of image size to the actual object size.

Secondary colors—Colors formed by the combination of two primary colors. Yellow, magenta, and cyan are secondary colors.

Separation light—A third light used in portrait photography to separate the subject and background, add depth, and vary background tone.

Solenoid—An electrical device that delays a camera shutter for a certain length of time.

Speedlamp—An electronic flash lamp. Also called a repeating flash unit.

Stereogram—Two pictures mounted for stereoscopic viewing.

Stereopair—Two pictures of the same subject photographed so they can provide a three-dimensional effect when viewed properly.

Stereoscope—A binocular optical instrument for assisting the observer to view two properly oriented photographs to obtain a three-dimensional impression.

Strip—A series of overlapping exposures matched together to form one long picture. Also called a **line overlap.**

Subtractive color film process—A color process in which the viewed colors are a result of filtration or subtraction of colors from a white viewing light.

Tilt angle—The angle between the camera axis and the vertical in oblique aerial photography. This is the complement of the angle of depression.

Time-intensity curve—A curve showing the brightness and the flash time of a flashbulb and how the brightness varies during the flash.

Tonal separation—The difference in shades of gray in a black and white photograph.

Universal Polar Stereographic Grid System—The grid system that covers the polar regions south of 80° south and north of 84° north.

Universal Transverse Mercator Grid System—The grid system that covers the earth from the 80th parallel south to the 84th parallel north.

Vanishing point—The point of convergence where a group of lines seems to meet and image size disappears.

Vertical—An aerial photograph made with the optical axis of the camera perpendicular to the earth's surface.

Zone focusing—Setting the lens to cover an entire depth of the zone in which the photographic subject is likely to be.

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Chief of Staff.

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NG: State AG (3); Units—Same as active Army except allowance is one copy to each unit.
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For explanation of abbreviations used see AR 320-50.

* U.S. GOVERNMENT PRINTING OFFICE: 1969 O—364-091

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C., 20402