SUBCOURSE
SS0509

EDITION
8

LABORATORY PROCEDURES

THE ARMY INSTITUTE FOR PROFESSIONAL DEVELOPMENT

ARMY CORRESPONDENCE COURSE PROGRAM

US ARMY STILL PHOTOGRAPHIC SPECIALIST
MOS 84B SKILL LEVEL 1

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LABORATORY PROCEDURES

SUBCOURSE NO. SS0509-8
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US Army Signal Center and Fort Gordon
Fort Gordon, Georgia

Five Credit Hours

GENERAL

The laboratory procedures subcourse is designed to teach tasks related to work in a photographic laboratory. Information is provided on the types and uses of chemistry, procedures for processing negatives and prints, and for mixing and storing chemicals, procedures for producing contact and projection prints, and photographic quality control. This subcourse is divided into three lessons with each lesson corresponding to a terminal learning objective as indicated below.

Lesson 1: PREPARATION OF PHOTOGRAPHIC CHEMISTRY

TASK: Determine the types and uses of chemistry, for both black and white and color, the procedures for processing negatives and prints, the procedures for mixing and storing chemicals.

CONDITIONS: Given information and diagrams on the types of chemistry and procedures for mixing and storage.

STANDARDS: Demonstrate competency of the task skills and knowledge by correctly responding to at least 75% of the multiple-choice test covering preparation of photographic chemistry.

(This objective supports SM tasks 113-578-3022, Mix Photographic Chemistry; 113-578-3023, Process Black and White Film Manually; 113-578-3024, Dry Negatives in Photographic Film Drier; 113-578-3026, Process Black and White Photographic Paper).

Lesson 2: PRODUCE A PHOTOGRAPHIC PRINT

TASK: Perform the procedures for producing an acceptable contact and projection print.

CONDITIONS: Given information and diagrams on the procedures for producing contact and projection prints.

STANDARDS: Demonstrate competency of the task skills and knowledge by correctly responding to at least 75 percent of the multiple-choice test covering production of a photographic print.

(This objective supports SM tasks 113-578-3025, Make Black and White Contact Prints; 113-578-3029, Make Black and White Projection Prints; 113-578-3030, Dry Mount Photographic Prints.)

Lesson 3: PHOTOGRAPHIC QUALITY CONTROL

TASK: Perform quality control procedures in a photographic laboratory, including cleanliness, visual inspection, processing controls, replenishment, and chemical measurement (pH).

CONDITIONS: Given information and diagrams pertaining to cleanliness, visual inspection, processing control, replenishment, and chemical measurement (pH).

STANDARDS: Demonstrate competency of the task skills and knowledge by correctly responding to at least 75 percent of the multiple-choice test covering photographic quality control.

(This objective supports SM tasks 113-578-3022, Mix Photographic Chemistry; 113-578-3039, Evaluate Black and White Photographic Negatives; 113-578-3023, Process Black and White Film Manually; 113-578-3026, Process Black and White Photographic Paper).

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INTRODUCTION TO LABORATORY PROCEDURES

As a photographer, you are required to perform a variety of tasks in the photographic laboratory. These tasks range from preparing chemicals to processing film and paper, contact and projection printing, print finishing, quality control measures, color film and print processing, copy photography, and portrait photography. Due to the length and depth of these topics, they are discussed individually in separate subcourses.

If you are an amateur photographer or planning to take up photography as a hobby, the information contained in this course will help you produce a professional quality print. It is common knowledge in the field of photography that the work done in the lab can make or break a photographer. So it is very important that you learn everything you can about lab procedures. Knowing the characteristics and limitations of film and developers will allow you to make the right choices when shooting an assignment.

***** IMPORTANT NOTICE *****

THE PASSING SCORE FOR ALL ACCP MATERIAL IS NOW 70%.

PLEASE DISREGARD ALL REFERENCES TO THE 75% REQUIREMENT.

LESSON 1
THE PHOTOGRAPHIC PROCESS

TASK

Determine the types and uses of chemistry for both black and white and color; the procedures for processing negatives and prints; and the procedures for mixing and storing chemistry.

CONDITIONS

Given information and diagrams on the types of chemistry and procedure for mixing and storage.

STANDARDS

Demonstrate competency of the task skills and knowledge by obtaining a minimum passing score of 75 percent of the multiple-choice test covering the preparation of photographic chemistry.

REFERENCES

None

Learning Event 1:
PREPARE PHOTOGRAPHIC CHEMISTRY

1. Chemical reaction. When an exposure is made, a chemical change takes place in the light-sensitive silver halides. During this chemical change, the silver halides suspended in the gelatin emulsion layer produce a latent, or invisible image.

a. The film is then immersed in a photographic developer. The purpose of the developer is to continue the chemical reaction that began with the exposure to light. This step converts the exposed silver halides to black metallic silver, forming a visible image.

b. After the image appears, the emulsion is rinsed in stop bath to stop further development of the halides.

c. Next, the film is placed in a fixing solution. The fixer converts the unexposed, undeveloped silver halides into water-soluble salts. These are removed in the fixer and the image is made permanent.

2. Types of chemicals. There are many types of chemicals, too numerous to name, but we can categorize them into two basic groups. They are:

- black and white chemicals
- color chemicals

a. Black and white chemicals can be further divided into the following types:

(1) Film chemicals

(2) Paper chemicals

b. The color chemicals can also be broken down into the following groups:

(1) Negative chemicals

(2) Printing chemicals

(3) Positive/reversal chemicals

3. Black and white chemicals. When we refer to chemicals, we mean the chemicals that come in premixed containers. They come either in powder or liquid form ready to be mixed with water to make a working stock solution.

a. A stock solution is mixed with water to get a base solution for temporary storage in bottles. When needed, this solution is further diluted with water, and after use, it is discarded. Examples of this are paper developers and some film developers, such as DK-50.

b. A working solution is one that is used as is. That is, once the chemical is mixed with water, it is ready for use. Examples of this are most film developers, stop bath, and fixer.

c. To give a general idea of the makeup of different chemicals, we have a simple chart for mixing DK-50, stop bath, and fixer form base chemicals.

d. In Figure 1-1 is a list of some of the black and white chemicals commonly used in the military. This list contains the names or numbers of a chemical, it's most notable characteristics, and storage life. You should perform a processing test on chemicals which have been stored for extended periods, even though the chart indicates they may still be good.

CHEMICAL	USE	TRAY	TANK WITH LID	STOPPED BOTTLE FULL	STOPPED BOTTLE HALF FULL
D-19	High contrast	24 hrs	1 mo	6 mos	2 mos
DK-50	General use: film	24 hrs	1 mo	6 mos	2 mos
D-72	General use: papers, fast dev film	24 hrs	2 wks	3 mos	1 mo
D-76	Low contrast, max shadow detail: film	24 hrs	1 mo	6 mos	2 mos
HC-110	General use: film	stock	solu-tion	6 mos	2 mos
	DILUTION A	24 hrs	2 mos	6 mos	2 mos
	B	24 hrs	1 mo	3 mos	1 mo
	C	24 hrs	2 mos	6 mos	2 mos
	D	24 hrs	1 mo	3 mos	1 mo
	E	24 hrs	1 mo	2 mos	1 mo
	F	24 hrs	DO NOT	STORE	-----
MICRO-DOL-X	Fine Grain, med contrast: film	24 hrs	1 mo	6 mos	2 mos
A-10	Machine process, dev: paper	------	-----	Ind	-----
S-30	Machine process, stabilizer: paper	------	-----	Ind	-----
SB-1a	Stop bath: film and paper	3 days	1 mo	Ind	Ind
F-5	Fixer: film and paper	1 wk	1 mo	3 mos	2 wks
F-7	Rapid fixer: film & paper	1 wk	1 mo	3 mos	2 wks

Figure 1-1. Photographic chemicals used by the military

4. Color chemicals. Color-processing chemicals are divided into three types: negative, transparency, and prints. Color chemicals come in different-size kits. This allows you to select the proper amount of chemistry to meet your processing needs.

a. Color negative chemicals are designed to process <u>only</u> color negative film. This is commonly referred to as the C-41 process. The Kodak Flexicolor kits used for processing negative film contains a developer, bleach, fixer, and stabilizer.

b. Reversal/positive color chemicals are designed to produce <u>only</u> color transparencies. The Army uses the standard Ektachrome (E-6) processing kit. Each kit consists of the following chemicals: first developer, reversal bath, color developer, conditioner, bleach, fixer, and stabilizer.

c. Color print chemicals are the counterpart to the black and white paper chemicals. Black and white chemicals can process almost any black and white paper on the market. However, color print chemicals are designed to process only one type of print paper, Ektacolor. The Ektaprint-2 (EP-2) kit consists of a developer, bleach-fix, and stabilizer.

d. The color chemicals are under constant revision to improve the quality of color photography. Again, the chemical processes used are C-41 for film, EP-2 for paper, and E-6 for transparencies. The actual mixing procedures, mixing precautions, and processing steps will be discussed in the subcourse on color photography.

5. Mixing chemicals. Regardless of the type of chemical, black and white or color, you must follow the manufacturer's mixing instructions. Black and white chemicals usually have their mixing instructions on the back of the package or bottle (fig 1-2); color chemicals have a mixing instruction sheet packed with them (fig 1-3). These instructions will tell you how to mix the chemicals, at what water temperature, how much water to use, how much to add to obtain a working solution and mixing precautions.

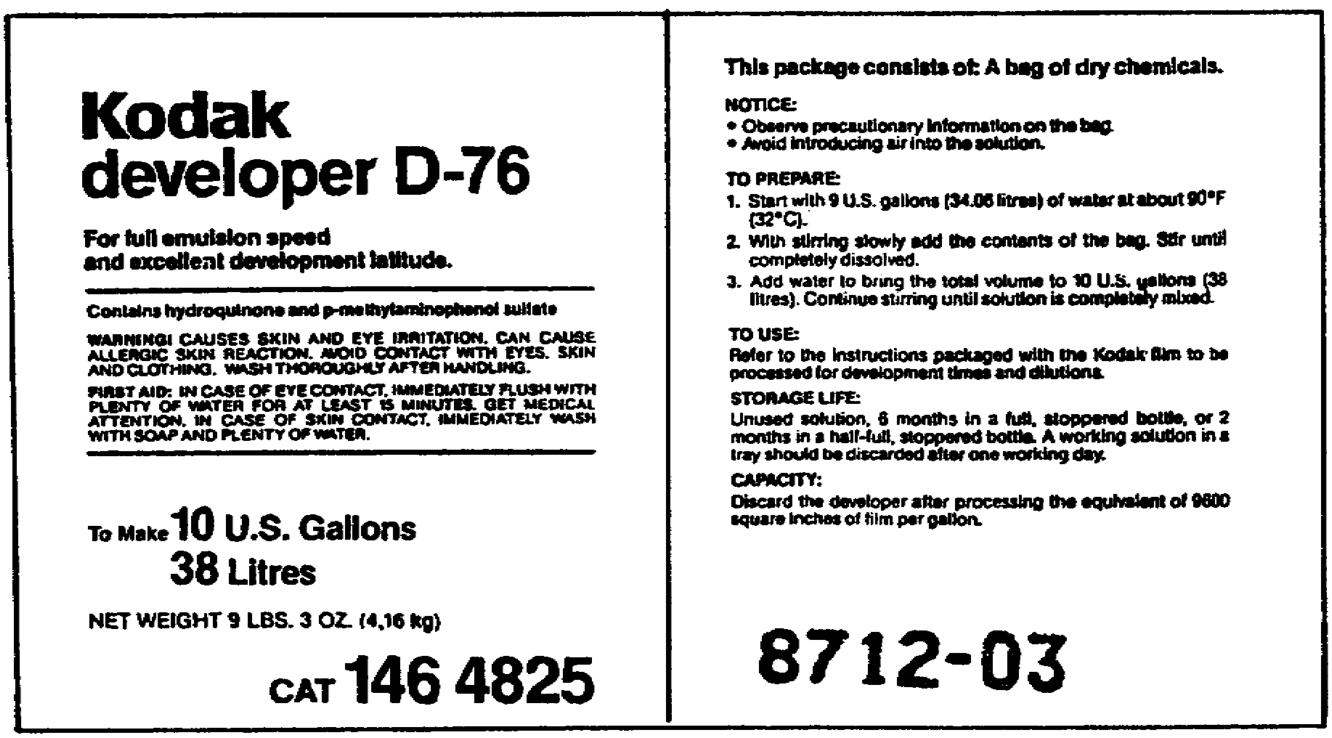


Figure 1-2. Black and white mixing instructions

a. Always read and follow the instructions carefully. Making a mistake when mixing can be very costly and time consuming for everyone. If you make a mistake discard all chemicals and start again with a new set of chemicals.

NOTE: Always add the chemical to the water. Do not pour the chemical in the mixing container and then add water. This is especially important when mixing an acid solution.

b. When mixing more than one chemical, mix them in the order they are used (developer, stop bath, and fixer). This procedure will minimize the possibility of contaminating the chemicals if the mixing container was not washed thoroughly. The film goes from the developer into the stop bath and then into the fixer so a little of each chemical is carried over to the next chemical. There is no harm done when it happens in that order. However, it doesn't take much fixer added to the stop bath or developer to contaminate them. Likewise, a small amount of stop bath in the developer will cause contamination.

c. Thoroughly wash all the equipment you use after mixing each chemical including the thermometer, mixing stick and measuring beaker. If you are using an automatic mixer, flush the pumps and hoses with fresh water.

6. Summary. You should now be familiar with the basic types of photographic chemicals, the types of film that are processed in different chemicals, and how to prepare these chemicals. If there are any areas you are not sure of, go over them again. If you feel competent in your knowledge, go on to Learning Event 2.

KP 686481

KODAK FLEXICOLOR DEVELOPER
for Process C-41

To Make 1 U.S. GALLON (3.8 LITRES) of Solution

Liquid volumes are given in the U.S. and metric systems.

THIS PACKAGE CONSISTS OF Part A—A bottle of liquid.
Part B—A bottle of liquid.
Part C—A bottle of liquid.

NOTICE:

- Observe precautionary information on containers and in instructions.
- After emptying, rinse each container with a small amount of water (approximately 1 fluidounce [30 mL]) and add the rinse to the mix tank.
- Provide good general room ventilation in all chemical-handling situations. The mixing area should have local exhaust.
- Avoid introducing air into the solution.

PRECAUTIONS IN HANDLING CHEMICALS: The developing agent used in this process may cause skin and eye irritation and an allergic skin reaction. In case of contact, immediately flush skin or eyes with plenty of water. We recommend using clean, protective gloves and eye protection, especially in mixing or pouring solutions and in cleaning the darkroom. Before removing gloves after use, rinse their outer surfaces with a non-alkaline hand cleaner and water. Keep all working surfaces such as bench tops, trays, tanks, and containers clean and free from spilled solutions.

TO PREPARE:

1. Start with 3 quarts (2.8 litres) of water at 80 to 90°F (27 to 32°C)
2. With stirring, add the contents of the bottle of Part A.
3. With stirring, add the contents of the bottle of Part B.
4. Add the contents of the bottle of Part C.
5. Add water to bring the total volume to 1 gallon (3.8 litres). Stir until the solution is completely mixed.

PART A Contains potassium carbonate
WARNING! CAUSES SKIN AND EYE IRRITATION. Avoid contact with eyes, skin, and clothing.
First Aid: In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. In case of eye contact, get medical attention. KEEP OUT OF THE REACH OF CHILDREN.

PART B Contains hydroxylamine sulfate
WARNING! HARMFUL IF SWALLOWED. HARMFUL IF ABSORBED THROUGH SKIN. CAUSES SKIN AND EYE IRRITATION. CAN CAUSE ALLERGIC SKIN REACTION. Avoid contact with eyes, skin, and clothing. Wash thoroughly after handling.
First Aid: In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing. Wash contaminated clothing before reuse. If swallowed, if conscious, immediately rinse mouth and induce vomiting by giving 2 glasses of water and touching back of throat with finger or blunt object and/or induce vomiting with syrup of ipecac. Call a physician immediately. KEEP OUT OF THE REACH OF CHILDREN.

PART C Contains 4-(N-Ethyl-N-2-hydroxyethyl)-2-methylphenylenediamine sulfate
WARNING! HARMFUL IF SWALLOWED. MAY CAUSE KIDNEY INJURY. VAPOR IRRITATING. CAUSES SKIN AND EYE IRRITATION. CAN CAUSE ALLERGIC SKIN REACTION. Avoid breathing vapor. Avoid contact with eyes, skin, and clothing. Use with adequate ventilation. Wash thoroughly after handling.
First Aid: In case of eye contact, immediately flush with plenty of water for at least 15 minutes. In case of skin contact, immediately wash with soap and plenty of water. If inhaled, remove to fresh air. If swallowed If conscious, immediately rinse mouth and induce vomiting by giving 2 glasses of water and to ching back of throat with finger or blunt object and/or induce vomiting with syrup of ipecac Call a physician immediately: KEEP OUT OF THE REACH OF CHILDREN.

READ THIS NOTICE: This product will be replaced if defective in manufacture, labeling, or packaging. Except for such replacement, this product is sold without warranty or liability even though defect, damage, or loss is caused by negligence or other fault.

Thank you for using Kodak chemicals.
EASTMAN KODAK COMPANY, Rochester, N.Y. 14650

KP 686481 8-85 Kodak and Flexicolor are trademarks. Printed in U.S.A

Figure 1-3. Color mixing instruction sheet

Learning Event 2:
DESCRIBE FILM PROCESSING

1. Types of film. As an Army still photographer you will be working with many types of film. In order to process the film correctly, you must be familiar with the type being used. The following chart list a few of the commonly used types of roll and sheet film in military photography.

a. To aid you in identifying the film you will be processing, the metal cassettes or packages in which roll film is enclosed are clearly labeled.

b. Once sheet (cut) film has been removed from its original box and loaded into a cut film holder, there is only one way to determine the type of film you are handling. Each piece of sheet film has a notched identification code cut in one corner. The emulsion side (dull surface) faces you when the notch is in the upper right-hand corner, as shown in Figure 1-5.

Identification of Roll Films	
Description of film class	Commercial designation
Panchromatic, regular speed	Kodak Plus-X Panchromatic Film (35mm) Eastman Verichrome Pan Film
Panchromatic, low speed	Kodak Panatomic-X Film (35mm) Kodak Panatomic-X Film (rolls)
Infrared	Kodak Infrared Film, (35mm)
Panchromatic, extra high speed	Kodak Tri-X Film (35mm) Kodak Tri-X Film (rolls)
Panchromatic, ultra high speed	Kodak Royal-X Pan Film (120 and 620 size)

Figure 1-4. Identification of various films

Identification of Sheet Films	
Panchromatic, regular speed	Kodak Portrait Panchromatic Film
Orthochromatic, extra high speed	Kodak Royal Ortho Film
Orthochromatic, regular speed	Kodak Super Speed Ortho Portrait Film
Orthochromatic, process, high contrast	Kodak Contrast Process Ortho Film
Orthochromatic, process, medium contrast	Kodak Commercial Ortho Film
Panchromatic process, high contrast	Kodak Contrast Process Panchromatic Film
Infrared	Kodak Infrared Film
Infrared, high speed	Kodak High Speed Infrared Film
Panchromatic, high speed	Kodak Super-XX Panchromatic Film Kodak Super Panchro-Press Film, Type B
Panchromatic, extra high speed	Kodak Royal Pan Film Kodak Tri-X Panchromatic Film
Blue sensitive, low speed, high contrast	Kodak Aerial Positive Film Kodak Commercial Film
Panchromatic, ultra high speed	Kodak Royal-X Pan Film
Identification of Film Packs	
Panchromatic, regular speed	Kodak Verichrome Pan Film
Panchromatic extra high speed	Kodak Tri-X Film
Panchromatic, ultra high speed	Kodak Royal-X Pan Pack Film

Figure 1-4. Identification of various films (cont)

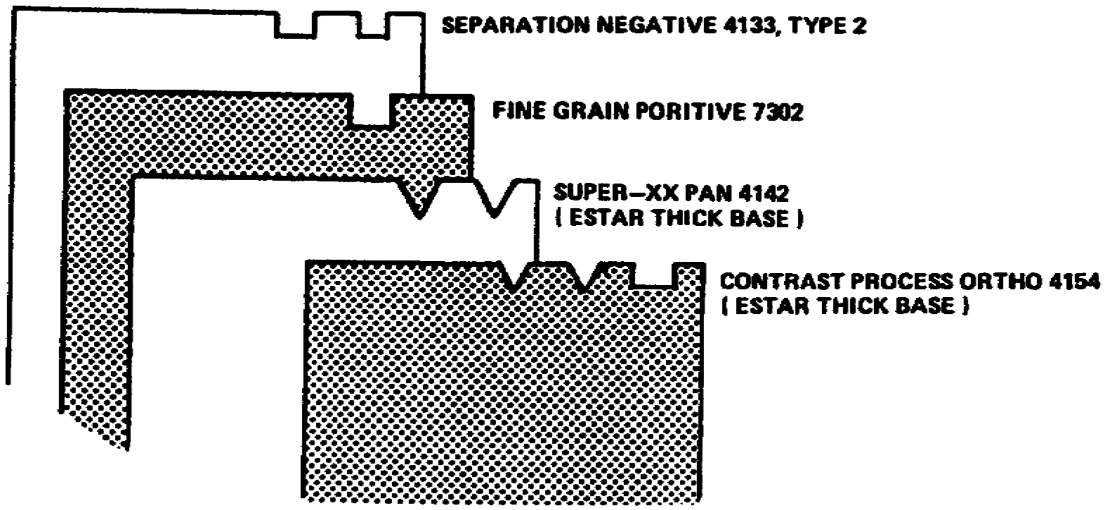


Figure 1-5. Sheet film identification notches

The original box from which the sheet film was taken has the notched identification code printed on it.

2. Developing methods. Besides using automatic film processors, which are not covered in this subcourse, there are only two processing methods: tray and tank processing. Tray processing involves the use of rectangular trays. Tank processing employs an open tank or closed daylight processing tank (fig 1-6). A daylight tank is equipped with a light-tight cover, and processing solutions are poured in and out, without removing the lid, through a light trap located in the center of the cover.

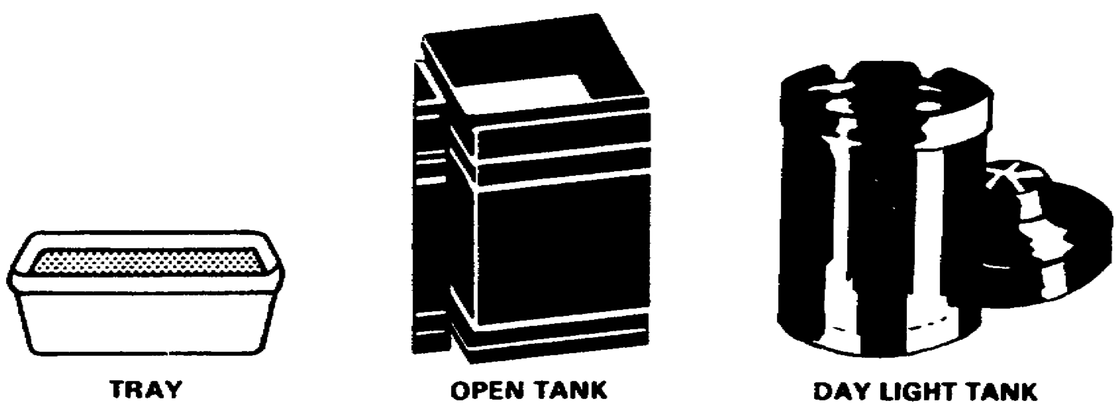


Figure 1-6. Processing methods

a. The best developing method to use is determined, primarily, by the type of film being processed. Another factor to consider is the equipment available for processing the film.

b. The quantity of film may also affect the processing method you choose. If you have 16 rolls of 35 mm film, you could process it in the daylight tank, but you may have to make two processing runs. Better uniformity is achieved and larger quantities of film can processed in an open tank.

c. In some cases, the method is a matter of preference. You can process rolls of 120 or 35 mm film in an open tank or a daylight tank. Most photographers prefer to use the daylight tank for small quantities of film.

d. Following is a chart showing the processing methods available for different sizes of film and the maximum quantity you can process in each (at the same time). For example, 35 mm film can be processed in a daylight tank (64 oz) maximum quantity of 8 rolls or it can be processed in an open tank (3 1/2 gal), maximum quantity 36 rolls.

> NOTE: When we speak of processing 36 rolls of film in an open tank, we are referring to film of the same type, such as TRI-X. You cannot process 15 rolls of TRI-X with 15 rolls of PAN-X, because they have different processing times.

e. Once the method is determined, you must make sure that the equipment is <u>free of old dried chemicals</u>. These particles may fall onto the film emulsion while loading the film into equipment and cause "spots" on the film.

3. The processing sequence. Processing consists of a series of steps that will develop the invisible image into a visible image through the use of chemical solutions.

a. Let's assume that you have determined the type of film you are processing and the method you will use to process it. The steps in the processing sequence (fig 1-7) are as follows:

(1) Presoak. The presoak is an optional but very useful step in the processing sequence. Prior to developing, the film is immersed in water to soften the emulsion, assisting the rapid penetration of the developing agent.

(2) Developing. The exposed film is immersed in a chemical solution (called developer) consisting of a developing agent, buffer, accelerator, and preservative. This starts the chemical action changing the exposed silver halides to a black metallic silver.

(3) Stop bath. This step stops the action of the developing agent, preventing further development. Acetic acid is commonly used. Since the fixer also contains an acid, any carry-over prolongs the life of the fixer.

(4) Fixing. The film is then placed in another chemical, sodium thiosulfate, which renders the unexposed and undeveloped silver halides water soluble.

(5) Washing. A water wash removes all chemicals, water soluble salts and other contaminants from the film.

(6) Wetting agent. A wetting agent consisting of a high quality detergent that replaces the water particles allowing for faster drying and the reduction of water spots during drying.

(7) Drying. The film is dried which results in a “negative". A negative is an image of the subject photographed in which the various tones appear reversed.

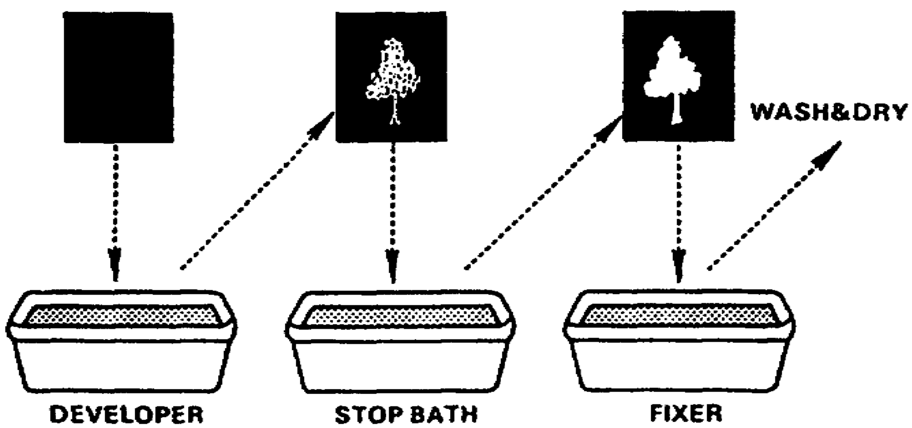


Figure 1-7. Developing process

b. Film handling is complicated by the fact that the emulsion is sensitive to light and must be protected until fixation is well under way. Observe the following procedures when you are handling film:

(1) Remove the undeveloped film from its original wrapper in total darkness. Failure to do this will cause the film to become fogged and useless.

(2) Always handle film gently and by the edges.

(3) Never touch the film surface.

(4) To prevent defects from forming during processing, agitate the film so that the solutions can act uniformly over its' entire surface.

4. Type of developer. The type of developer chosen for processing your film is dependent on the film type and the desired final product. To make an informed decision you must be familiar with the characteristics of developers and film.

a. The initial phase of development affects the density of highlights and shadow areas to approximately the same degree. As the developing action continues, however, highlight areas of the negative, or shadow areas of prints are rendered more dense. Therefore, the developing action should be stopped when the contrast between the light and shade tones is most satisfactory. Actually, since development is done in total darkness, several processing "runs" of test film may be necessary to determine the optimum developing time.

b. The speed of the developing action is determined primarily by the activity of the developer. However, the film type is also a factor.

c. There are several types of developers, and each differs in activity and provides different qualities of development. In selecting a developer, consider the type of film, the conditions under which it was exposed, and the results desired. Accordingly, select a low working developer for negatives requiring a low or medium degree of development, and an active developer to obtain a high degree of development. For example, aerial photographs produced under poor light conditions require a very vigorous developer to bring out as much of the image as possible, while portrait negatives usually call for a much less active developer.

d. Listed below are a few developers currently available and a brief description of their characteristics:

Developer	Developer Characteristics
D-19	Coarse - high contrast
DK-50	Average - normal contrast
D-76	Fine - low contrast
Microdol X	Fine - normal contrast

5. Developing temperature and time. When developing any type of film, there are two major factors determining the final outcome of your negative, the temperature of your developer and the time (minutes) you keep the film in the developer.

a. The normal processing temperature is 68 degrees Fahrenheit (20 degrees Celsius). If the developer is above 75 degrees

Fahrenheit, the film emulsion swells excessively, becomes soft, and is easily damaged during handling.

b. With care, film can usually be processed without damage at temperatures up to 80 degrees Fahrenheit. At such temperatures, however, it is necessary to use special processing solutions and procedures.

c. At temperatures below 65 degrees Fahrenheit, there is no danger of excessive swelling but the activity of the solution is slowed. This causes the processing time to become inconveniently long, and there is danger of incomplete action in development, fixing, and washing. Whenever possible, solution temperature should kept between 68 degrees and 75 degrees Fahrenheit.

d. There is a definite correlation between time and temperature as shown on the sample time-temperature graph below. When it is impossible to maintain solution temperature at the desired level, time can be shortened or lengthened to compensate.

Example: Good results will be achieved with MICRODOL X at 10 minutes at 65 degrees Fahrenheit, and DK-50 (1:1) at 7 minutes at 65 degrees Fahrenheit.

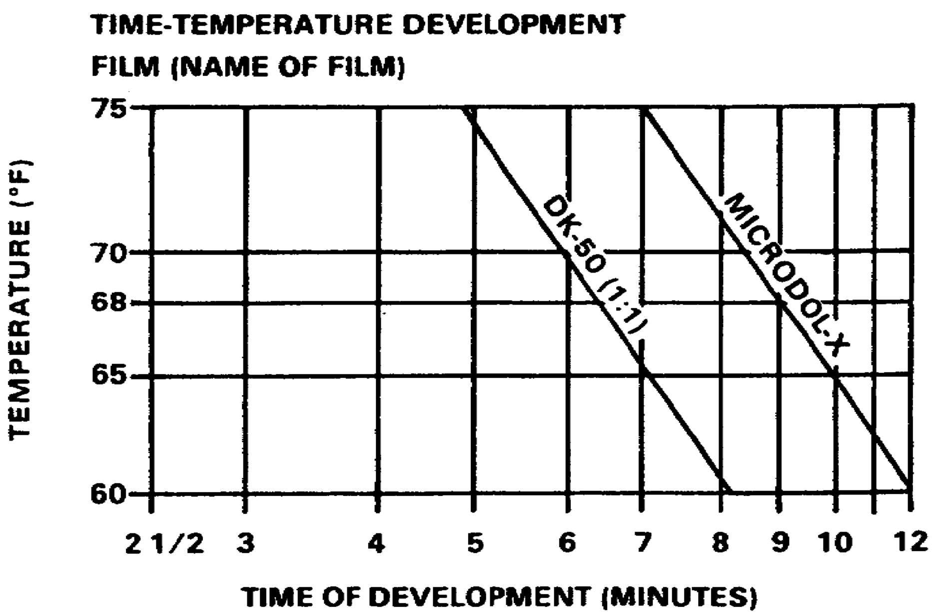


Figure 1-8. Time-temperature development graph

e. When the room temperature is within the suitable working range, there aren't any temperature control problems. When the room temperature is high, the solutions may be cooled

by placing the tray or developing tank in a sink, tray, or tank containing cold water. If ice is available, it is usually satisfactory to put it in the outside container. Ice should never be added directly to the processing solution. As it melts, it dilutes the solution and changes its strength.

f. The temperature of all solutions (developer, rinse, fixing bath, and wash) should be as near to each other as possible. If there is considerable difference in temperature between the solutions, the emulsion is subjected to excessive expansion and contraction which may cause it to wrinkle and/or crack. This condition is known as reticulation.

6. Stop bath. When a negative is removed from the developing solution, the emulsion is soft and small amounts of developer remain in the emulsion and on its surface. If the developer is not removed, it will continue its reaction and cause stains. To remove surplus developer, the negative is placed in a rinse bath, generally referred to as the stop bath.

a. There are three general types of stop baths: water, acid, and acid-hardening. Each has its specific purpose and should be used accordingly.

(1) Water stop bath. As a rinse, water helps to retard development by diluting the developer. This reduces contamination of the fixing bath. It is suitable for both negatives and prints, and sometimes precedes the acid rinse in print processing to avoid the formation of gas bubbles that may cause damage to the emulsion.

(2) Acid Stop Bath. The acid stop bath contains acetic acid and water. An acid rinse is more effective than water, because it stops all development by neutralizing the action of the developer. This action prolongs the life of the fixing bath.

(a) When working with photographic paper, use the recommended acetic acid rinse bath. Use 1 1/2 ounces of 28 percent acetic acid to 32 ounces of water. Do not use this bath for negatives developed in a highly alkaline solution such as Kodalith A & B because the violent reaction of the alkali with the acid may cause pinholes in the emulsion.

(b) If an acid bath is not available, rinse the emulsion thoroughly in water.

(3) Acid-hardening stop bath. An acid-hardening rinse consists of acetic acid, water, acid-pot, and chrome alum (the hardening agent). Use an acid-hardening rinse bath to

harden the film emulsion when processing at high temperatures or under tropical conditions.

(a) If temperatures are above 75 degrees Fahrenheit (24 degrees celsius), the acid stop bath should contain an antiswelling agent, such as sodium sulfate, and a hardening agent, such as chrome-alum. Sodium sulfate is recommended for temperatures for temperatures between 75 and 85 degrees Fahrenheit.

(b) A chrome alum bath should be used for temperatures between 75 and 95 degrees Fahrenheit.

(c) Under ordinary conditions the hardening agent in the fixing bath is sufficient, therefore a water or acid rinse may be used.

7. Fixing film. After the rinse or acid-stop bath, the film is placed into an acid-hardening fixing bath, usually called “hypo". The function of the fixing bath is to make it possible to remove the unexposed, undeveloped silver halides, which are still sensitive to light. During fixation, the undeveloped silver halides are converted to water soluble compounds (silver salts) that are no longer light sensitive.

a. Fixing time. The general yardstick for fixing time is twice the time required for clearing (“clearing" refers to the removal of the silver salts from the emulsion). However, since most film processing must be done in total darkness, we cannot tell when the film has cleared. For most negative materials a fixing time of 5 minutes is adequate. After repeated use the hypo is weakened by the dissolved silver halides and clearing time becomes progressively longer.

b. Hypos contain several ingredients to perform the functions described above.

(1) Silver halide solvent (fixing agent). Hypos must have a silver halide solvent, usually sodium thiosulfate (hypo). This chemical changes the undeveloped silver halides to water soluble compounds.

(2) Acid and neutralizer. Even though the film has been subjected to a stop bath, there still remains a considerable amount of developer in the emulsion. The acid or neutralizer (acetic acid), completely stops the development action and prevents stains.

(3) Preservative. When acid is added to the fixing bath, decomposition of sodium thiosulfate sets in. Sodium sulfite, a preservative, is added and combines with the decomposition (free sulphur) to form new hypo.

(4) Hardener. During development, the emulsion becomes soft and swollen. A hardening agent is added to prevent frilling (peeling of the emulsion) and minimize scratching. Potassium alum is used to harden the emulsion.

c. Types of fixing baths. There are three major types of fixing baths: plain, acid, and acid-hardening.

(1) Plain fixing bath. The standard plain fixing bath is seldom used except when preparing prints for toning. It contains sodium thiosulfate and water.

(2) Acid fixing bath. A satisfactory acid fixing bath contains hypo-acetic, acid-sodium sulfite and water. The acid fix is primarily used for prints.

(3) Acid-hardening fixing bath. An acid-hardening fixing bath contains a hardening agent, usually potassium alum, as well as a silver halide solvent, a neutralizing agent, and preservative. This type of hypo is suitable for film and if diluted, paper.

8. Washing and drying film. Negatives and prints must be washed to remove the hypo left in the emulsion after fixing. This is necessary because an unwashed, or improperly washed, emulsion will stain, change color, and fade. Therefore, washing photographic emulsions is just as important as any other part of the development process.

a. Washing time depends largely on water temperature and the amount of fresh water coming in contact with a negative or print. Most chemicals diffuse faster in warm water. With photographic material, however, the warmer the water, the more the film gelatin swells. Water temperature should be within the range of 65 to 75 degrees Fahrenheit.

b. As the washing proceeds, the hypo remaining in the sensitized material is halved in equal periods of time. For example, the average negative gives up approximately half of its hypo in 15 seconds of direct contact with running water.

After 30 seconds, one-fourth of the hypo remains, and so on, until eventually the remaining hypo is negligible. Accordingly, washing time depends on the degree of agitation and the amount of fresh water coming into contact with emulsion (fig 1-9). Where water shortages exist, the reduced wash time will save large amounts of water.

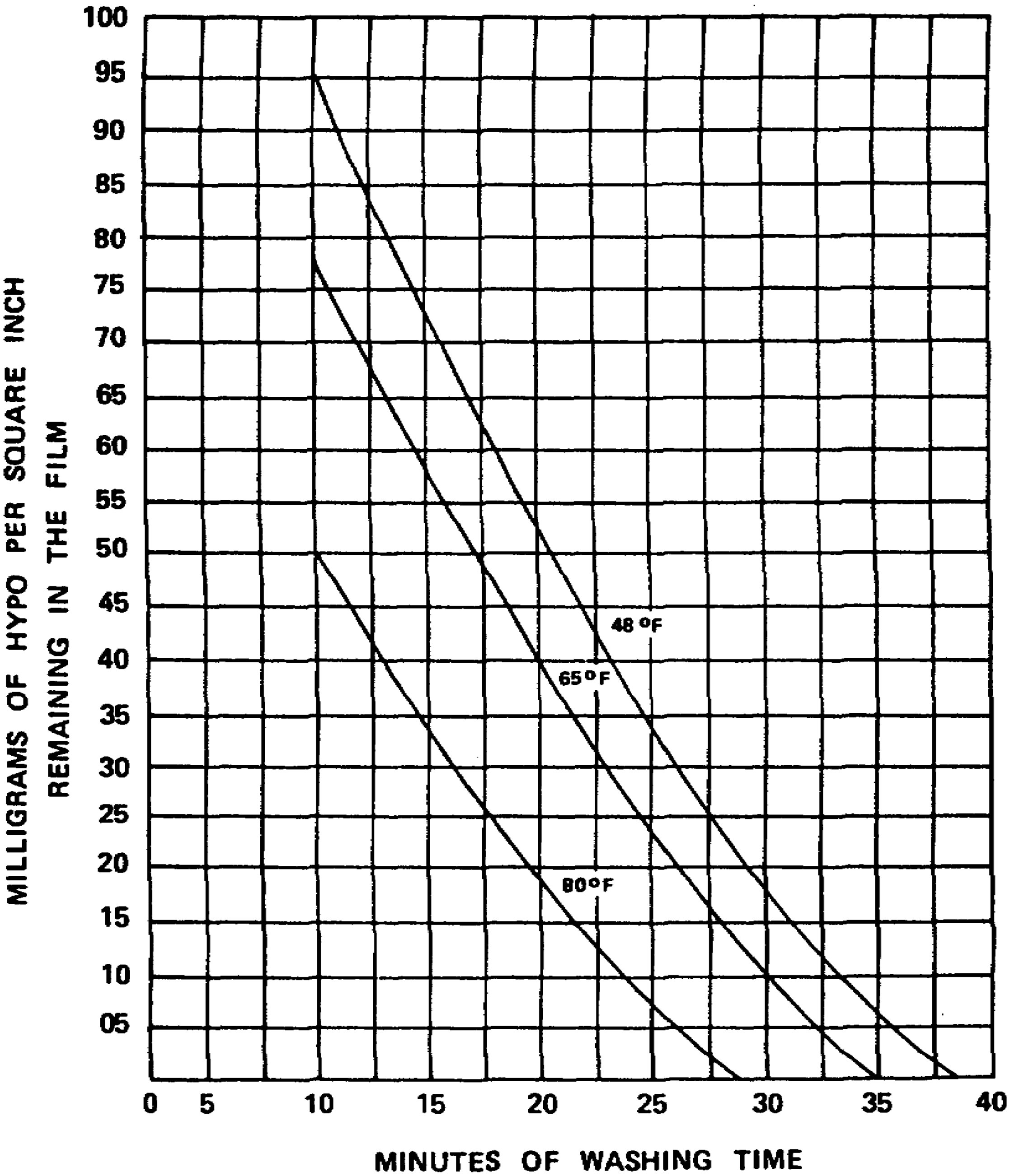


Figure 1-9. Rate of hypo elimination from a negative

c. If you use a hypo eliminator, the washing procedure is modified as follows:

(1) Remove the film from the fixer. Rinse the film in running water for 30 seconds to remove the excess hypo.

(2) Immerse your film in hypo eliminator for 2 minutes.

(3) Wash the film in running water for 5 minutes.

d. As you can see the use of hypo eliminator drastically reduces the wash time for film, saving you both time and water.

e. Wetting agent. After the film has been washed, it should be placed in a wetting agent. Photo-flo is the common term used when referring to a wetting agent. Wetting agents are high grade detergents that prevent the formation of water marks by breaking down the water molecule, reducing the surface tension of water, and allowing the film to dry evenly. The film should be immersed in the photo-flo for one minute.

f. Film drying. When film is dried under normal temperature conditions, the process is relatively simple. The major concern at this point is dust. Foreign particles suspended in the air are easily trapped in the soft emulsion. For this reason a clean, dust free environment is a necessity when drying your film. If speed is essential, the film can be dried in a diluted methyl alcohol bath or a cabinet with warm circulating air.

9. Tray Processing Sheet Film. To ensure good negative uniformity in the processing of sheet film, the following procedure should be used.

a. Use four trays slightly larger than the film. Arrange the solutions in the following order:

(1) Preliminary water bath (presoak)

(2) Developer

(3) Stop bath

(4) Fixer

b. Pour at least 1/2 inch of solution into each tray.

c. Arrange the trays in a row as follows: the preliminary water bath, the developer, the acid stop bath, and the fixer last (fig 1-10).

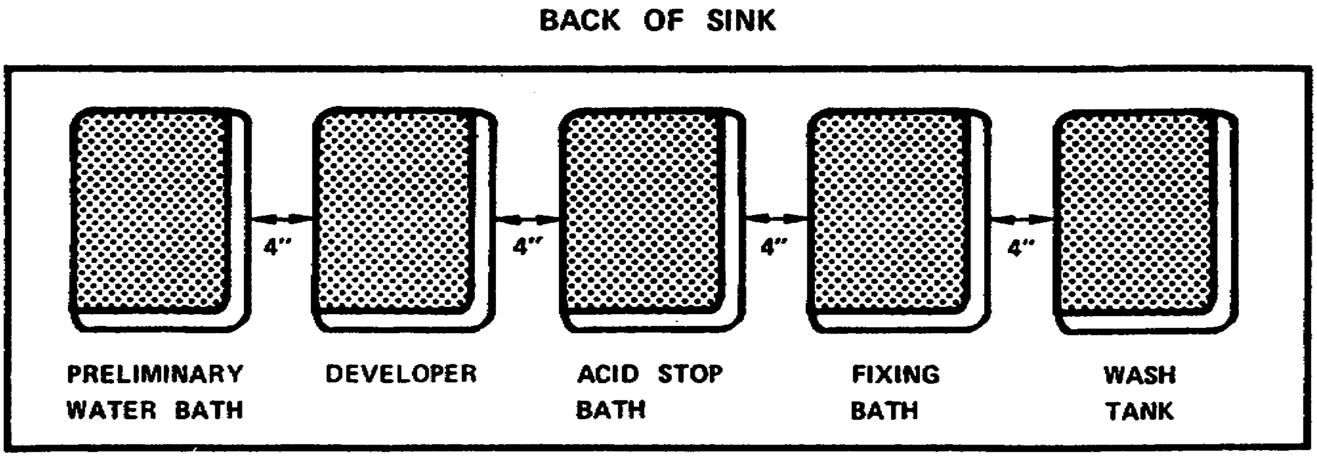


Figure 1-10. Arrangement of trays in tray processing

d. Place the trays far enough apart to prevent the solution from splashing into an adjacent tray during processing. Approximately two inches will do.

e. Bring solutions to the proper temperature and set the time. Arrange the holders containing the exposed film in a convenient, dry position, turn off the lights, and remove the film from the holders.

f. Be careful not to get dirt and fingerprints on the film, especially when handling it in the dark.

g. Immerse the exposed film, one sheet at a time emulsion side up in the tray of water. Each sheet must be completely covered with water before the next one is placed over it.

h. When all the film is in the tray, draw one sheet carefully from the bottom of the pile and place it on the top, emulsion down. Handle the film only at the extreme edges and do not let a corner or an edge of any sheet of film dig into the film emulsion below it. Repeat this replacement from bottom to top, always inverting the film, until individual film sheets have been leafed through twice. This will prevent the film from sticking together and will dislodge any air bubbles that may have formed.

i. Start the timer and transfer film quickly, one sheet at a time from the bottom of the pile into the developer tray. Continue rotation of the film from the bottom to the top throughout the development period.

j. At the end of the correct developing time, transfer the film, one at a time, to the stop bath. Then, leaf through the pile twice. Keep track of the order in which the film was placed in the developer, so it can be put into the stop bath in the same order. Failure to do so can result in overdevelopment of some of the film.

k. Transfer the sheets of film, one at a time, to the fixer. Continue replacement from bottom to top throughout the entire time required for fixing.

l. Wash the negatives thoroughly in running water for 30 minutes (less time if hypo eliminator is used) using the rotation method or by placing the negatives in hangers and using a washing tank.

m. After the washing is completed, immerse the film in photo-flo rotating the sheets for one minute.

n. Finally, attach a clip to one corner of each negative and hang the negatives in a drying cabinet. Excess surface moisture is best removed with a viscous sponge.

10. Tank processing of sheet film. In a tank, developer is less exposed to the action of air. As a result, solutions in a tank last longer and can be used for processing a larger quantity of film than solutions in a tray. To process sheet film in a tank, use the following procedures:

a. Use a least three tanks - one for developer, one for the stop bath, and one for the fixer

b. Bring the solution to the correct temperature and set the time for the appropriate development time.

c. Arrange sheet film holders and film developing hangers so they are easily accessible. Then turn off the lights.

d. Remove the film from the holders and load them into the hangers.

e. Start the timer and lower the hangers into the developer.

f. Agitate the hangers vertically in the solution for about 10 seconds, striking the tops of the hangers sharply against the top of the tank once or twice to dislodge air bubbles clinging to the film.

g. Leave the hangers undisturbed for one minute. Then lift the hangers clear of the solution, tilting them to the left at a 45 degree angle for two to three seconds before placing them back into the solution. Lift the hangers from the solution again, this time tilting them to the right, then place them back into the solution. Repeat this procedure for 5 seconds every 30 seconds or for 10 seconds every 60 seconds. Tap the hangers on the top of the tank one or two times to dislodge any air bubbles at the end of each agitation sequence (fig 1-11).

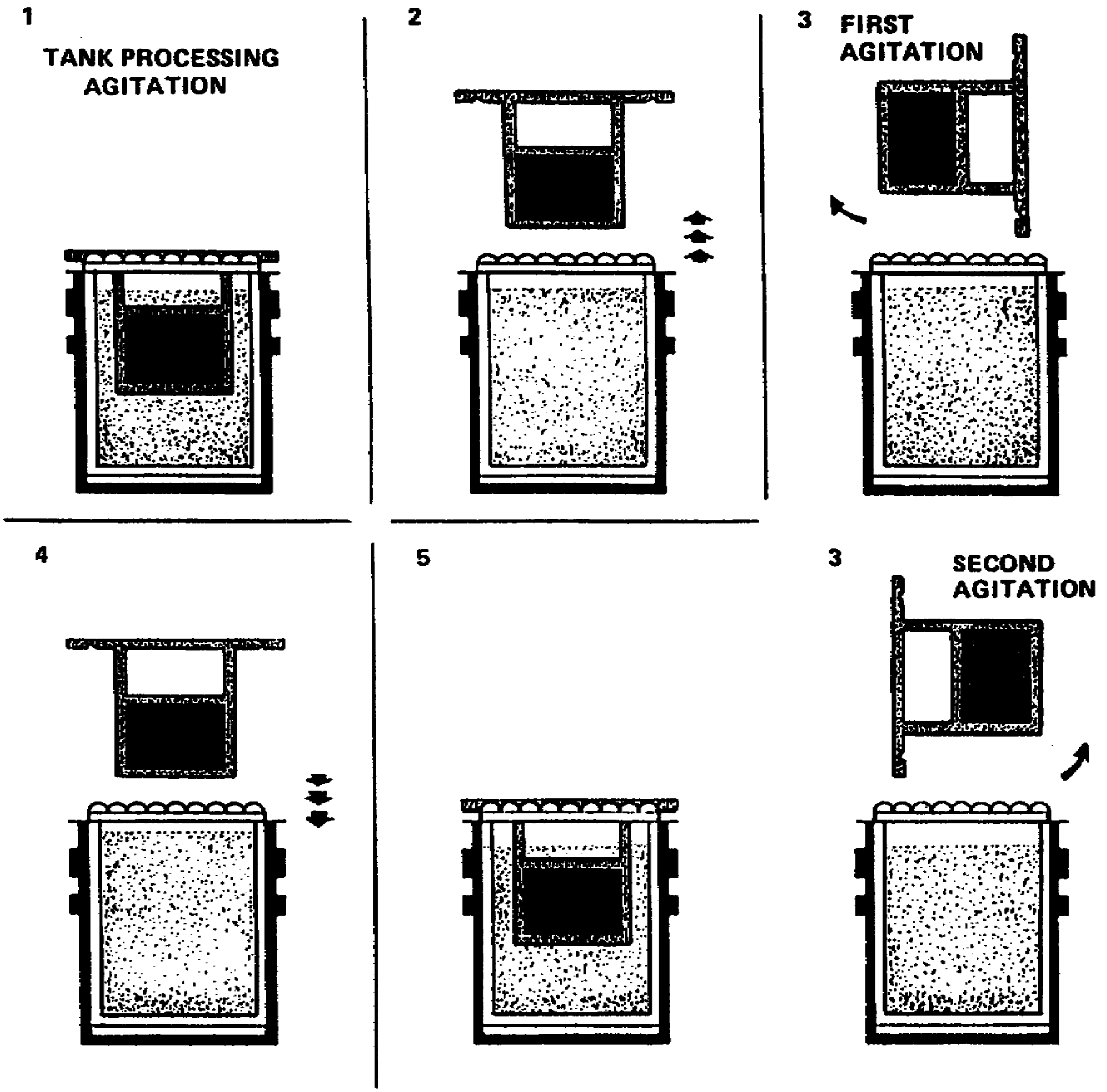


Figure 1-11. Cut film agitation

NOTE: If sheet film is not tilted during the agitation sequence, processing streaks may occur.

h. Ten seconds before the end of the development time, lift the hangers from the developer, drain them, and transfer them to the stop bath. Agitate the film continuously for 30-60 seconds.

i. Set the time to 5 minutes and transfer the hangers to the fixing tank. The initial agitation is continuous for the first 30 seconds. As with the developer, you need to agitate the film for 5 seconds every 30 seconds or for 10 seconds every 60 seconds. Fixing time is 5 minutes.

j. Wash the negatives thoroughly in running water for 30 minutes (5 minutes if a clearing agent is used).

k. Remove the hangers from the wash water and immerse them in the photo-flo for one minute. Tap the hangers to dislodge any air bubbles.

l. Remove the film from the hangers. Then attach a film clip to one corner of the film and hang it in a drying cabinet. Eliminate excess surface moisture with a photo chamois or viscous sponge.

11. Processing roll film in large tank. To process roll film in a tank, proceed as follows:

a. Use at least three tanks - one for the developer, one for the stop bath, and one for fixer.

b. Bring the solutions to the correct temperature and set the timer for the appropriate development time.

c. Arrange roll film and film developing reels so that they are easily accessible, then turn off the lights.

d. Remove the film from the roll and load it onto the processing reel. Place the loaded reels on a processing stick or in a processing rack.

e. Start the timer and lower the reels into the developer.

f. Using an up and down (vertical) motion, agitate the reels for 15 seconds, striking the reels sharply against the bottom of the tank once or twice to dislodge air bubbles clinging to the film. Thereafter, agitate the film for 5 seconds every 30 seconds or for 10 seconds every 60 seconds.

g. At the end of the development time, lift the reels from the developer, drain them, and transfer them to the stop bath. Use continuous agitation in the stop bath for 30-60 seconds.

h. Transfer the reels to the fixing tank and agitate for 15 seconds. Agitate the film for 5 seconds every 30 seconds or 10 seconds every 60 seconds. The room lights may be turned on after the first two minutes.

i. Wash the negatives thoroughly in running water for 30 minutes (5 minutes if a clearing agent is used).

j. Transfer the film to the photo-flo. Tap the reels against the bottom of the tank to dislodge any air bubbles. Remove the reels from the photo-flo after one minute.

k. Take the film off the reel. Attach a film clip to the top and bottom of the film and hang it in a drying cabinet. Eliminate excess surface moisture with a photo chamois or viscous sponge.

12. Processing roll film in a daylight tank. Processing roll film in daylight tanks is the most popular method used. The following steps describe the procedure for loading and processing film in daylight tanks.

a. Arrange the film, reel and tanks on the counter in front of you. <u>Turn off the darkroom lights</u>. Load the film onto the reels. Then place the loaded reel(s) in the tank and place the light tight cover on the tank.

b. Turn on the room lights and set the timer for the developer.

c. Remove the small cap located in the center of the light tight cover. Do <u>not</u> remove the cover. Tilt the tank at a 45-degree angle and pour the developer through the hole in the center of the cover, as fast as you can, without spilling it.

d. Replace the cap and agitate the tank for 15 seconds. You can agitate by twisting or rotating the tank or by inverting the tank and bringing it back to an upright position. Repeat this procedure for the entire agitation cycle. At the end of each agitation cycle tap the tank firmly to dislodge any air bubbles.

e. At the end of the development time, remove the lid and pour the developer solution from the tank through the hole as fast as possible.

f. Fill the tank with stop bath. Agitate continuously for 30-60 seconds.

g. Drain the stop bath, pour the fixer into the tank and agitate the film continuously for 15 seconds. Continue this agitation for 5 seconds every 30 seconds or 10 seconds every 60 seconds. After 2 minutes in the hypo you can remove the light tight cover and finish processing under room lights.

h. Drain the hypo and wash the film by allowing a stream of water to run through the tank or by removing the film reels to a washing tank. As usual the wash time is 30 minutes unless a clearing agent is used. Washing efficiency can be improved by dumping the water from the tank every three minutes and then placing the tank back under the running water.

i. Drain the water and pour the photo-flo into the tank. Tap the tank to dislodge the air bubbles.

j. Drain the photo-flo and hang the film to dry.

13. Summary. You should now be familiar with the processing of photographic film to include: identification, developing methods, how to determine time and temperature, and manual processing steps. If there is any area you are not sure of, go over it again. If you feel competent in your knowledge of the material, go on to Learning Event 3.

Learning Event 3:
DESCRIBE PHOTOGRAPHIC PAPER

1. General. As with film, when light strikes the minute silver halides embedded in the gelatin layer of a paper emulsion, a chemical change takes place creating the latent image. Subsequent processing in chemical developers makes the invisible latent image visible.

2. The anatomy of photographic paper.

a. Photographic print papers (fig 1-12) are composed of the following layers:

(1) A paper base

(2) A baryta layer

(3) An emulsion

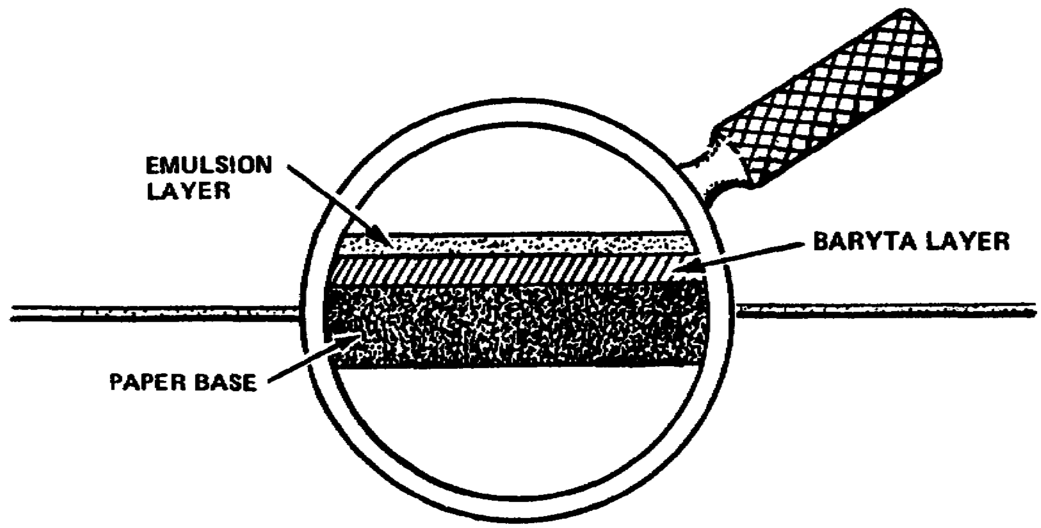


Figure 1-12. Cross section of a sheet of photographic printing paper

b. Let's briefly discuss the three layers of photographic printing paper.

(1) Base. The base must be chemically pure to ensure that it will not interfere with the chemical processes to which the emulsion is subjected. Accordingly, the paper is an ideal support for sensitized emulsions because it reflects light and is flexible, economical and durable. Paper is available with a single, medium or double weight base.

(2) Baryta layer. Although paper has a high degree of natural reflectivity, the quality of a photographic print can be increased if the reflectivity is increased. This is accomplished by adding to the paper a gelatin layer containing baryta crystals (fig 1-12).

(3) Emulsion. The emulsion layer, which contains minute silver halides suspended in a gelatin medium is thin. Printing paper emulsions need only reproduce the tonal range of a negative, while film emulsions must have the capability of interpreting brightness, shadows, colors, and related details of a given scene or object. Accordingly, printing paper emulsions are of a much simpler structure than film emulsions.

Paper emulsions are particularly thin to increase the reflectivity of the finished print and to make it extremely flexible.

c. There are three types of printing paper emulsions: bromide, chloride, and chlorobromide. The main difference among these types is speed and latitude.

3. Development papers. Development papers (photographic printing papers) have a gelatin surface that contains light-sensitive silver halides. Following exposure, the papers are subjected to a precise chemical development process.

a. Chloride papers. Chloride papers, have a slow speed emulsion and contain silver chloride. They have a fine grain and produce deep blacks. Because of low sensitivity to light, they are used for contact printing. Chloride papers are made in different contrasts, ranging from soft (low contrast) to hard (high contrast).

b. Bromide papers. Bromide papers, which have a faster emulsion speed than chloride papers, achieve sensitivity through the use of silver bromide halides. They produce blacks that are warmer than those of chloride papers. Because of the relatively high sensitivity to light, these emulsions are particularly suitable for projection printing.

c. Chlorobromide papers. Chlorobromide paper emulsions, which contain both silver chloride and silver bromide halides, produce pleasing warm blacks. Emulsion speed lies between that of chloride and bromide papers. Chlorobromide papers are produced in a wide range of contrasts and are used for both contact and projection printing. This type of paper is standard in the Army.

4. Paper contrast. Density can be referred to as the amount of metallic silver deposited in any area of an emulsion. The difference between the densities of the various areas within the emulsion is called contrast. Since a bright area of a subject reflects the greatest amount of light, it is called the highlights. On the negative the highlight portion will have the greatest density. On the print it will have the least density, therefore appearing as white. On the other hand, any portion of the scene reflecting little or no light is called the shadow area. This portion of the negative will appear dark or black. All the brightness values which lay between these two extremes are called the middle tones and are represented on the paper in varying shades of gray. The difference in brightness values, ranging from the highlights through the middle tones to the shadows is called “subject contrast". Normal contrast is represented by a full range of densities. High image contrast consists only of highlights and shadow with little or no gradation of tones between them. Low image contrast has

very little difference between the tones and will appear with an overall grayish cast.

a. If all scenes were lit exactly the same and if all negatives had the same contrast, then printing the image would be a simple matter. However, all things are not equal and to produce a print with normal contrast we must have printing papers which can compensate for either too much or too little contrast within the negative.

b. There are two major classifications of paper available to help us obtain prints which have normal contrast. They are graded contrast and variable contrast.

(1) Graded contrast papers. Each manufacturer of photographic printing paper has classified the range of contrasts for these papers according to his own standards. Therefore, the paper of a particular grade number and description may not agree with that of another carrying the same description. However, papers currently available conform in a broad sense to the following scale.

No. 0 - Extremely low contrast
No. 1 - Low contrast
No. 2 - Normal or Medium contrast
No. 3 - Moderate contrast
No. 4 - High contrast
No. 5 - Extremely high contrast

(a) For normal or average contrast negatives, a normal or medium contrast paper is accepted as the one giving the best results. If a normal negative were printed on a grade 0 paper the entire picture would be shades of gray with no real blacks and no light highlights. If a normal negative were printed on a grade 5 paper then the final image would lack a range of middle tones and would appear mostly as black and white.

(b) Low contrast negatives are printed on high contrast paper in an attempt to get normal contrast in the photograph.

(c) High contrast negatives are printed on low contrast grades to achieve normal contrast in the image.

(d) One drawback to graded contrast papers is that you must purchase a separate box of paper for each contrast grade.

(2) Variable contrast paper, commonly called multi-grade or polycontrast, combines the complete scale of contrast ranges in one paper. This versatility is achieved with a special chlorobromide emulsion. Unlike graded contrast paper

which is sensitive to blue light, the silver halides in the emulsion of polycontrast paper are “treated" so that some are sensitive to blue light and others are sensitive to green. The green-sensitive halides affect the low contrast portions of the print and the blue-sensitive halides affect the high contrast regions. This allows the paper to produce varying contrast responses upon exposure to different colored lights. The photographer, instead of using different grades of paper, places one of a series of colored filters under the projection printer lens to achieve a specific contrast.

(a) Up to ten filters may be available to permit the widest possible contrast range. The filters are numbered and, in the case of Kodak's filter kits, range from 1 for very low contrast to 4 for very high contrast. They range in color from yellow, for low-contrast, to deep magenta, for high contrast. When a yellow filter (which absorbs some of the blue light) is in place, a higher ratio of green to blue halides are exposed thereby yielding overall lower print contrast. The deeper the shade of yellow the more the blue light is absorbed, causing lower contrast.

(b) On the other hand, when a magenta filter is used a portion of the green light is absorbed and we get higher print contrast.

(c) With Kodak filters an average or normal contrast negative is printed using a No. 2 filter. For a higher contrast negative use No. 1 or perhaps a No. 0 filter. For negatives which are slightly low in contrast you might use a No. 2 1/2 or a No. 3 filter.

5. Paper - base, surface texture, weight, and size.

a. The base can be one of two types, fiber-based or resin-coated (RC). There are advantages and disadvantages to both types.

(1) Fiber-based paper produces deeper black tones and more brilliant whites than RC paper does. In addition, the image produced by fiber papers will last longer than those of RC paper. However, fiber papers do require considerably longer processing times. Because the chemicals are absorbed by the paper base, a greatly extended wash time is required to ensure archival quality.

(2) Resin-coated (RC) papers require very short processing times and only four minutes for the wash. These papers are ideal for mass production or when printing a <u>rush</u> work order. RC papers are well suited for areas experiencing water shortages or operations conducted in the field where adequate amounts of water may not be available. Due to the lack of

permanence in the image produced by these types of paper they are not suitable for historical photographs.

b. Photographic papers are available in several weights (thicknesses). The most common weights are single, medium and double. Army regulations or the customer will usually specify the weight or surface texture required. If not, the standard is single weight glossy. One of the reasons single weight is standard is that double-weight (fiber-based) takes nearly twice as long to wash and dry. It is also more expensive.

c. Texture refers to the look and feel of the surface of a finished print. There are a variety of surface textures available.

(1) Glossy surface papers are just that, smooth and glossy in appearance. This is the most commonly used type of surface for general photographic needs. Glossy papers will tend to make the image appear sharper, but can emphasize wrinkles and blemishes in portraits. As a result this surface is not used much in portraiture photography.

(2) Lustre surfaces lack the high sheen of glossy papers. They are suitable for many types of photos.

(3) Matte surfaced papers do not have any gloss in their appearance. This type of paper is often used for exhibition photos and ID photos such as passports.

(4) Silk surfaces have a linen-like look and feel to them. They make the image appear less sharp, down-playing minor scratches and negative defects. The softer image produced by these papers causes blemishes and wrinkles in portraits to be less noticeable. Their tendency to enhance a person's appearance in photos makes them very popular with portrait photographers. On the other hand, when the mission requires maximum detail glossy papers would be a better choice.

d. Printing papers which produce different tones are also available. The base may be described as producing brilliant whites or as a warm-tone producing paper. In addition, the emulsion may produce a warm black, a neutral black, or deep black image.

e. Below is a table of the different papers available from Kodak. The chart tells you the surface and weights available in each type of paper.

f. From the information on Table 1-1, we can go to individual listings of paper. These listings give more information on each type of paper, such as description, filters to use, safe light use, recommended developer, speed, etc. Listed below are some sample characteristics of paper.

(1) Kodak polycontrast paper - single weight
Kodak polycontrast paper - light weight (A only)

Selective contrast, general purpose enlarging speed paper with warm black image tones.

Single weight or light weight.

Contrast can be varied through seven half-grade steps by use of filters such as Kodak Polycontrast filters (Kodak Polycontrast Filter Kit listed in the “Filters" section).

Characteristic tint - white; surface - (A) smooth, lustre (lightweight only); (F) smooth, glossy (J) smooth, high lustre; (N) smooth lustre.

Kodak Safelight Filter OC (light amber), or equivalent.

Kodak Dektol, Ektalfo Type 1, D-72 developers (tones with several Kodak toners) recommended.

ANSI Paper Speed: white light - 160.

Primarily recommended for tungsten enlarging bulb.

(2) Kodak Ektamatic Paper - single weight.
Kodak Ektamatic SC Paper - light weight (A only).

High speed - selective contrast stabilization paper with warm black or neutral black image tone.

Single weight or light weight.

Characteristics: tint-white: surface (F) smooth, glossy; (A) light weight; (N) smooth, lustre.

When processed in stabilization processor, warm black image tone is produced; when tray processed, neutral black image tone is produced.

Contrast can be varied through 7 half-grade steps with filters such as Kodak Polycontrast Filters (Kodak Polycontrast Filter Kit listed in “Filters" section).

SURFACE –	F	A&N	J	M	E&G	K	R	Y	X
Texture	*Smooth*	*Smooth*	*Smooth*	*Smooth*	*Fine Grained*	*Fine Grained*	*Tweed*	*Silk*	*Tapestry*
Brilliance	*Glossy*	*Lustre*	*High Lustre*	*Matte*	*Lustre*	*High Lustre*	*Lustre*	*High Lustre*	*Lustre*
Kodak Black-and-White Material									
Ad-Type		A WH LW 1-4							
Azo	F WH SW 0-6 DW 1-3	N WH DW 1-4			E WH SW 1-4 DW 2,3				
Dye Transfer	F WH DW				G CR DW				
Ektabrome SC‡	F WH MW	N WH MW							
Ektalure					E WM-WH DW G CR DW	K WM-WH DW	R CR DW	Y WM-WH DW	X CR DW
Ektamatic SC	F WH SW, DW	N WH SW A WH LW							
Kodabrome RC	F WH MW S-UH*	N WH MW S-UH*							
Kodabrome II‡	F WH MW S-UH*	N WH MW S-UH*							
Kodabromide	F WH SW 1-5 DW 1-5	N WH SW 2-4 DW 2-4 A WH LW 2-5			E WH SW 2-4 DW 2-4 G CR DW 2-4				
Medalist	F WH SW 1-4 DW 2,3		J WH DW 2,3		E WH DW 2,3 G CR DW 2-4			Y CR DW 2,3	
Mural							R, WRM CR SW 2,3		
Panalure	F WH SW								
Panalure Portrait					E WH DW				
Polycontrast	F WH SW, DW	N WH SW, DW A WH LW	J WH SW, DW		G CR DW				
Polycontrast Rapid	F WH SW DW	N WH SW			G CR DW			Y CR DW	
Polycontrast Rapid RC	F WH MW	N WH MW							
Portralure				M WM-WH DW	G WM-WH DW		R CR DW	Y WM-WH DW	
Portrait Proof							R CR SW		
Resisto		N WH, SW 2,3							
Studio Proof	F WH SW								
Velox	F WH SW 1-4								
Velox Premier	F WH SW				E WH DW				
Velox Premier RC	F WH MW							Y WH MW	
Velox Unicontrast	F WH SW				E WH DW			Y-WH MW	

WH—White paper stock CR—Cream-white paper stock WM-WH—Warm-white paper stock
*Available in soft medium hard extra hard and ultra hard grades
‡For machine processing only

Table 1-1. Paper surfaces and weights

Very short processing time in stabilization processor produces prints that will keep a limited time.

Prints made permanent by fixing and washing. For use where processing time is at a premium, such as proofing deadline work, press, medical, military and police photography.

Well suited to machine stabilization processing.

Kodak Safelight Filter OC (light amber) or equivalent.

Recommend Kodak Ekatamtic A10 Activator and S30 Stabilizer; or tray develop in Dektol developer.

ANSI paper speed, white light, with stabilizing processor - 400; white light with tray process - 120.

Primarily recommended for tungsten enlarging bulb.

6. Summary. You should now be familiar with the characteristics of photographic paper including construction, surface, tint, and base. If there is any area you are not sure of, go over it again. If you feel competent in your knowledge of the material, go to Learning Event 4.

Learning Event 4:
DESCRIBE PRINT PROCESSING

1. Chemicals for printing. The chemistry for print development is similar to that of film development. It is possible to use the same developers, but for the best results use a developer specifically made for prints. The Dektol formula is a standard print developer used in most photographic laboratories. This developer will produce top quality prints when used in accordance with manufacturer's instructions. At most military photographic facilities, the type of paper has already been determined for you, due to the supply system and local commander's preference as to the type of print contrast needed to meet mission requirements.

a. But for the average paper development, Dektol developer is ideal. It has a longer shelf life after being mixed than most other developers.

b. There might be times when you have to use a special type of paper to produce a specific type of photograph. Then you must follow the paper manufacturer's recommendations as to what type of developer to use for the best results.

2. Developing paper using tray method

a. A good print is the result of proper exposure, full development, correct solution temperatures and, with polycontrast papers, the right contrast filter. Because prints are developed under safelight illumination, it is easy to be misled by the apparent contrast in the image. It may seem to be fully developed before it has been through its prescribed processing time; therefore prints, when dry, have a gray and flat appearance.

b. In the processing of prints, it is necessary to use trays that are larger than the prints and deep enough to hold ample solution. If possible, the trays used for the stop bath and fixer should be somewhat larger than the developer tray (fig 1-6). Many times the developer tray will have a raised “X" on the bottom to distinguish it from the stop bath and fixer. Set the trays up so that you have the developer on your left, followed by the stop bath, and fixer trays. Standardizing the tray set-up will minimize the risk of others in the lab from using the wrong tray when they process the prints. Proceed as follows in processing a single print:

(1) Slip the exposed print into the developer, emulsion side down.

(2) Ensure the entire print is immersed into the solution and that no air bubbles cling to the surface. Turn the print emulsion up.

(3) Agitate the paper as development gets under way and watch the appearance of the image. A normal print should develop gradually - shadows first, then half tones, and finally highlights. Development times will vary depending on the type of paper and developer being used. If the image appears quickly with a general mottling, the print was overexposed.

(4) The average print development time ranges from 1 1/2 to 2 minutes. Your chemical solution should be 70 to 74 degrees F to yield the best results.

(5) Once the desired contrast has been reached in your print, within the recommended time, you have to stop development. This is done by removing the print from the developer and transferring it to the stop bath. Be sure to drain the print of excess developer solution. Do this by holding the print (with tongs) by one corner for about 15 seconds over the developer tray.

(6) The stop bath stops any further development by neutralizing the developer. Use continuous agitation in the stop bath.

(7) When stop bath time is completed, (1 minute), drain the print for 15 seconds and transfer it to the fixer. The fixing time for paper ranges from 5 to 10 minutes. Use constant agitation the first minute and once every minute thereafter until the fixing time is up. Then remove the print from the fixer, drain it, and place it in the wash.

(a) Double fixing bath. In the mass production of prints, it is generally advisable to use two fixing baths.

This procedure will produce a more uniform and thorough fixation, conserve chemicals, and speed up the production.

(b) Standard practices in fixation must be followed closely since there are dangers in both overfixing and underfixing. Inadequate fixing often produces stains on prints. Overfixation tends to produce a thinning or weakening of the photographic image.

(c) Agitation prevents exhausted hypo from settling near the surface of the emulsion which would prevent quick and effective entry of the thiosulfate into the gelatin of the emulsion. Of the projected time required for complete fixing, the greatest proportion involves the entry and spread of the chemical into the emulsion. Accordingly, it is important to agitate the solution to speed up the process of chemical diffusion. Do not permit prints to overlap each other in the fixer for more than a few seconds, otherwise unequal fixing may occur.

(8) An optional tray full of water may be used as a holding tank until you have produced enough prints to make it worth your while to use a proper wash tank.

3. Washing and drying paper.

a. Washing the paper is normally done in an automatic print washer. This washer rotates the prints in rapidly changing water at 65 to 70 degrees F.

b. The washing time is determined by the type, size, weight, and quantity of prints to be washed; also if a hypo clearing agent was used.

(1) Smaller size prints (4x5 and 5x7) are separated more easily and therefore wash faster. Larger prints (8x10 and 11x14) stick together and need longer washing.

(2) Single weight papers need half the wash time as double weight papers.

(3) The quantity of prints washed will determine if increased wash time is needed. For example, 20 8x10 prints will wash faster than 100 8x10 prints.

(4) RC papers only require 4 minutes to wash, while fiber-based papers generally need 45 minutes.

c. If you use, and it is highly recommended, hypo clearing agent according to instructions, you can reduce the washing time. The new wash time will be 10 minutes for single weight and 20 minutes for double weight prints. As you can see, there is quite a time advantage when you use hypo clearing agent. Due to the extremely short wash time required by RC papers, the use of a clearing agent is not needed.

d. Once the prints have been washed, drying will complete the process. For fiber-based papers a drum dryer is needed. Drying is done very simply by placing the prints on the drying apron one at a time. If glossy prints are required, place the prints face up, all other prints will be placed face down on the apron. The average temperature is 180 degrees F at a speed of 4 or 5 FPM. The speed will vary as the drum is cooled by the wet prints. When the prints are done, they will drop into the print basket on the front of the dryer. RC paper cannot be dried using the drum dryer. The plastic coating will melt and the print will stick when contact is made with the hot drum. Special RC dryers which use a hot air circulation system are available for these types of paper.

Learning Event 5:
DESCRIBE EKTAMATIC PRINT PROCESSING

1. Ektamatic printing process. The need for rapidly produced prints of acceptable quality for facilities that support photojournalism is a taxing responsibility. Timely completion of many projects is possible only through the Ektamatic print processor being employed. The damp-dry print it produces is usable and has an adequate life-span for layout and reproduction.

a. Stabilization is the term applied to the photographic process which uses developer-impregnated paper, a developer activator, and a stabilizer for fixing the developed image. Special materials and processing equipment have been produced for this purpose. This section describes the basic principles of stabilization processing as they are related to the Ektamatic SC (selective-contrast) paper and the Ektamatic Model 214K processor (EH-91A).

b. Paper for stabilization processing. The paper and emulsion used for stabilization processing is similar to that used in conventional processing. Ektamatic SC paper is virtually identical to Kodak Polycontrast paper except for the processing ability. The primary difference is the presence of dry developing chemistry within papers used for stabilization processing. In addition, this type of paper is not available in as many variations of weight, sensitivity, and surface characteristics as normal paper.

(1) As a variable contrast paper, it requires the Kodak Polycontrast filter kit to achieve different degrees of contrast.

(2) Although it can be handled under the Wratten OC safelight, its sensitivity limits its exposure to the safelight to no longer than 3 minutes.

c. Processing methods. Ektamatic SC paper may be processed by conventional paper processing methods using a standard developer and fixer solution. However, the advantage of rapid processing necessitates use of special chemistry with this paper. Only two solutions are required to produce a visible, semipermanent image on the conventionally exposed paper.

(1) An activator solution, A-10, reacts with the developer-impregnated paper to convert the latent image into a visible image. A short stop or rinse bath is not required before stabilization.

(2) The stabilizer solution, S-30, neutralizes further effects of development and greatly reduces the emulsion's sensitivity to light. Note that the light sensitivity has been <u>reduced</u>, but not completely neutralized. The resulting degree of permanency of stabilized prints, therefore, depends on the extent of their exposure to heat, light, and humidity. Since stabilization-processed prints are normally produced for short life requirements such as proofs or for immediate reproduction by news media, their lack of permanence poses no problems.

(a) To achieve lasting permanence of Ektamatic SC paper, it must be fixed, washed, and dried by conventional methods.

(b) Procedures for obtaining permanent images are explained in the data sheet supplied with each package of paper.

d. Stabilization processing equipment such as the Ektamatic 214K squeegees the prints through rollers after they have passed through the stabilizer solution. The paper then is in a damp-dry condition with a semigloss finish. Complete drying occurs within a very few minutes at normal room temperatures. A glossy finish is possible only after drying with normal print drying equipment. Since this drying method normally requires heat, the print must first be fixed in conventional fixer then washed to prevent image deterioration.

2. Installing the model 214K Kodak Ektamatic Processor. The Ektamatic processor was designed to process exposed stabilization photographic paper. Sizes range up to 14 inches in width and 6 feet long. Two solutions (activator and stabilizer) are supplied in plastic bottles and no chemical mixing is necessary. The processor should be positioned

on a stand or table 27 to 30 inches high. Position the table near the enlarger or printer being used to expose the paper. Be sure to use the recommended safelights since the paper is light sensitive.

a. Assemble and level the processor.

(1) Be certain that the two drain bottles are inserted into the base of the processor as shown in Figure 1-13. Using the tray location hole, place the solution tray on the processor base. Insert the ends of the drain bellows into the drain bottles.

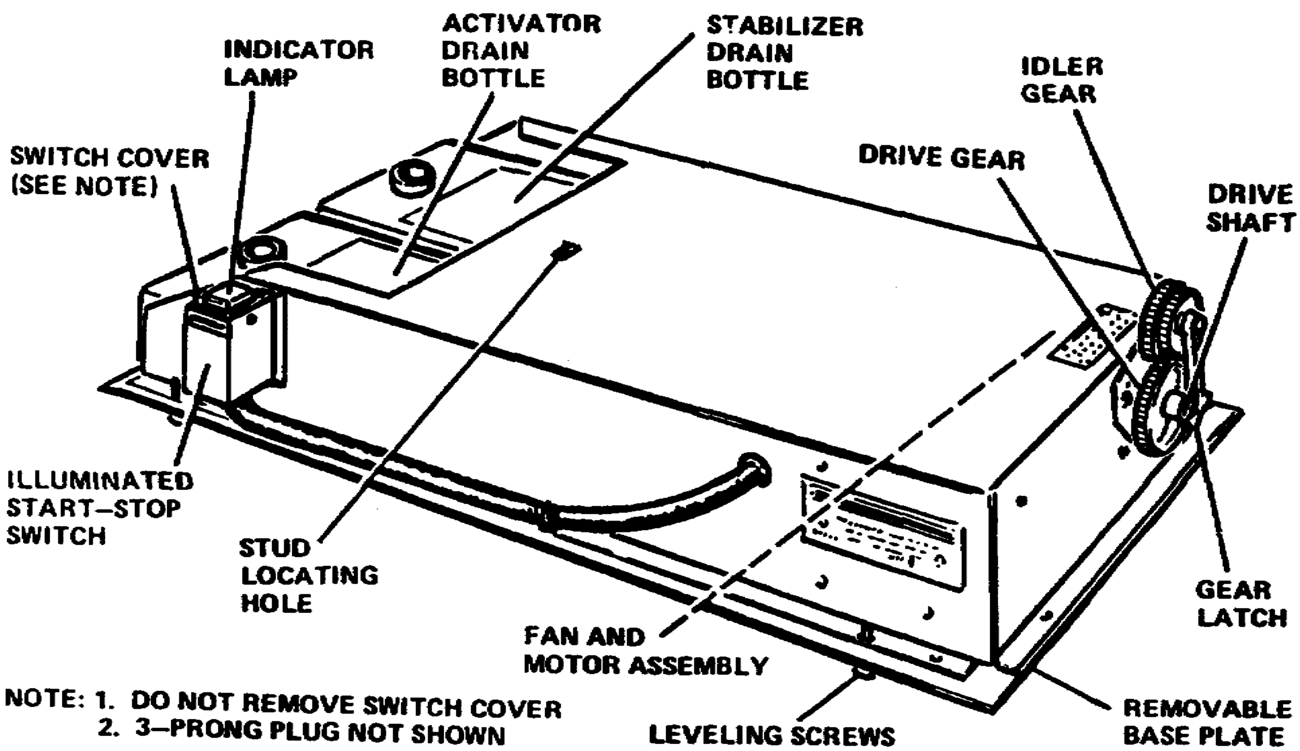


Figure 1-13. Processor base

(2) Level the processor (side-to-side and front-to-rear) by rotating the leveling feet. Use a bubble level on the center partition to check the side-to-side adjustment; span the width of the tray to check the front-to-rear adjustment.

(3) Leveling can also be done by filling the front section of the solution tray with water and adjusting the leveling feet until the water is at the same height along the entire length of the center partition. Compare the water level against the height of the flat surface near the front drain

bellows for front to rear leveling. Drain the water from the tray by depressing this drain bellow. Take out the solution tray and empty the drain bottle. Replace the bottle and the tray.

(4) As shown in Figure 1-14, place the processing rack assembly on the solution tray. Be sure the corners of the processing rack assembly rest in the recesses of the solution tray. After verifying the rack gear is meshed with the base idler gear, snap the hold-down latch over the shaft.

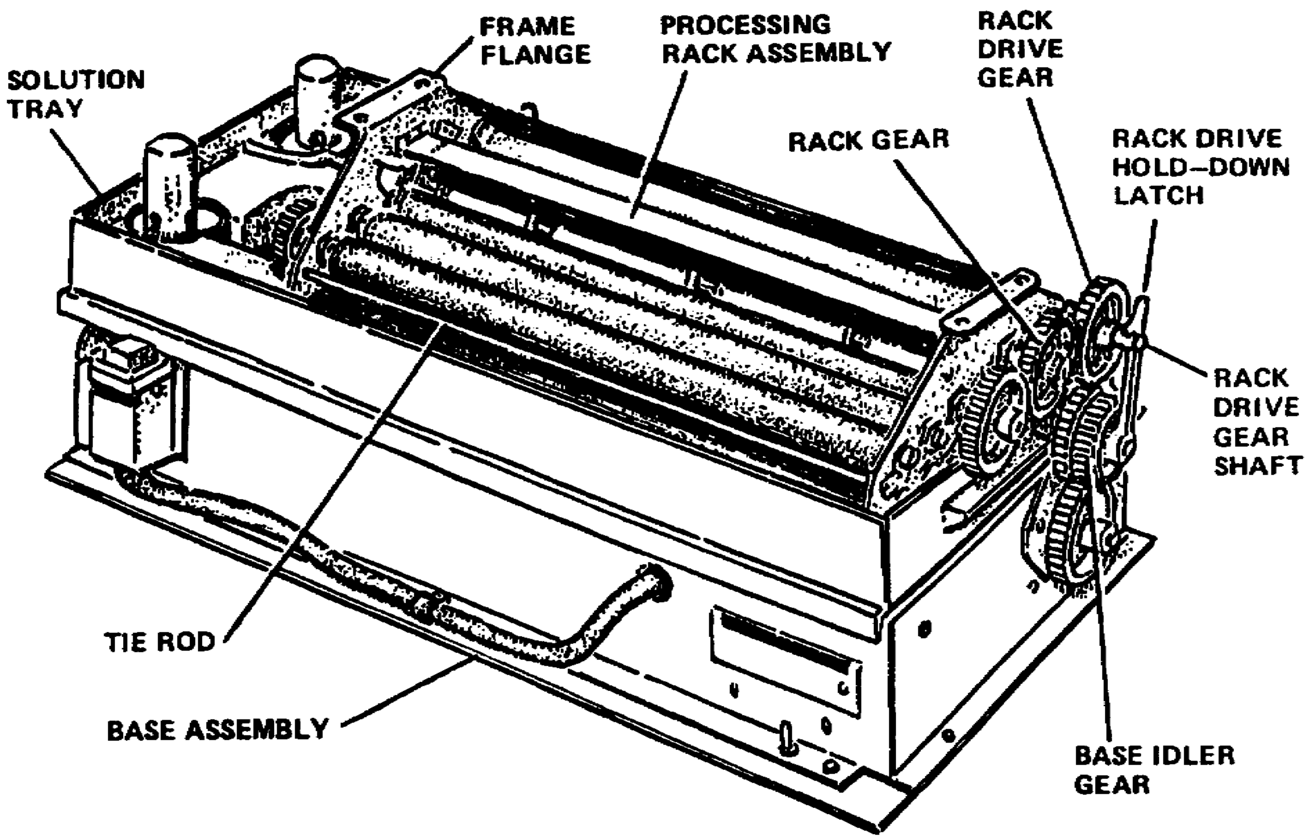


Figure 1-14. Rack assembly on the solution tray

(5) Assemble the Housing Assembly (fig 1-15) on the processor by tilting the front upward and toward the rear of the processor, hooking the Rod under the two brackets fastened at the rear of the processor base and then lowering the front of the housing assembly.

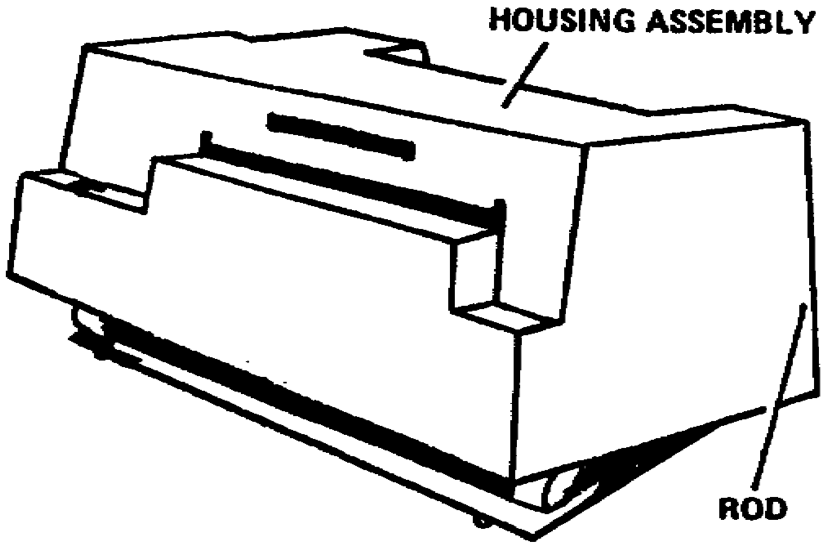


Figure 1-15. Housing Assembly

(6) Insert the Feed Shelf through the processor housing (fig 1-16) by tilting the front upward and inserting the shelf as far as it will go, then lower the assembly. This hooks each end of the shelf to the tie rod (fig 1-14).

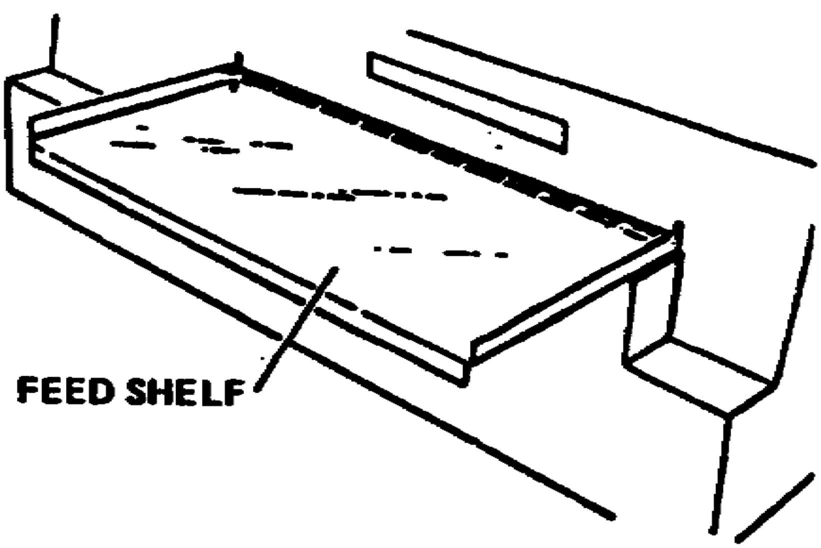


Figure 1-16. Feed shelf

(7) Install chemical supply bottles. After removing the caps from the one-quart solution bottles, install a solution level valve to each bottle as shown in Figure 1-17. Tighten each valve securely. To prevent the contamination of the solutions, always use the black solution valve with the activator and the red valve with the stabilizer.

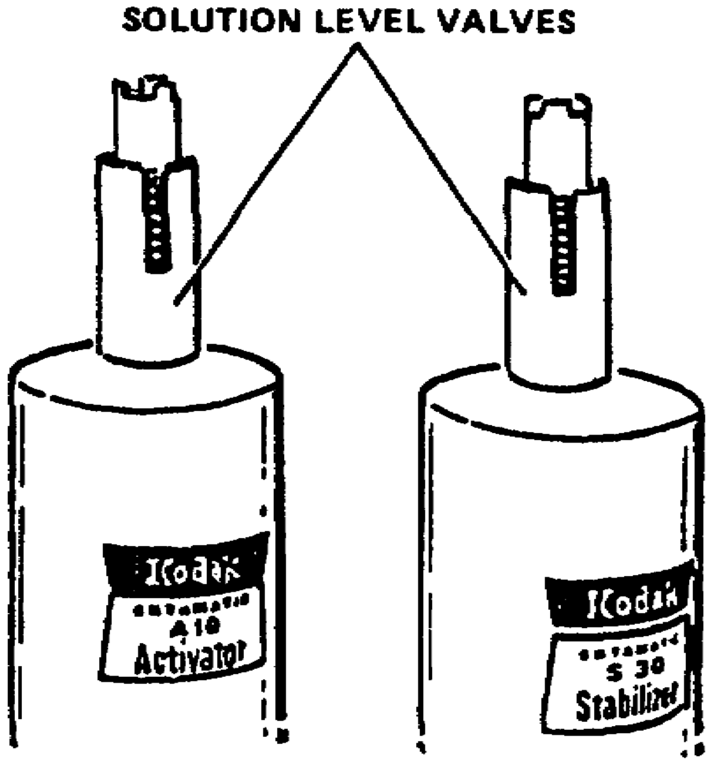


Figure 1-17. Solution level valves

(8) With the bottles held above the processor, turn them upside down and quickly insert them into the openings provided in the processor. Be sure each chemical bottle is inserted into its proper hole; i.e., the activator in the opening marked, “Activator," and the bottle of stabilizer inserted into the rear opening marked “Stabilizer" (fig 1-18). Ensure both bottles are seated firmly in the tray. When the processor is first started, slightly less than one quart of activator and slightly more than one quart of stabilizer are required to fill the trays. When a bottle is empty, install a full one.

b. Processing paper. To start the processor, press the start-stop button (fig 1-18). When the light in the button is lit, the processor is on. Whenever the processor is used intermittently, be sure to run the drive mechanism for several seconds before processing the first sheet of paper. If the processor is to be used frequently, the drive can be left running.

> CAUTION: Be very careful not to touch the emulsion side of the paper before processing. To avoid chemical contamination of the feed tray, be sure the processed prints do not come in contact with the tray or housing as they are removed.

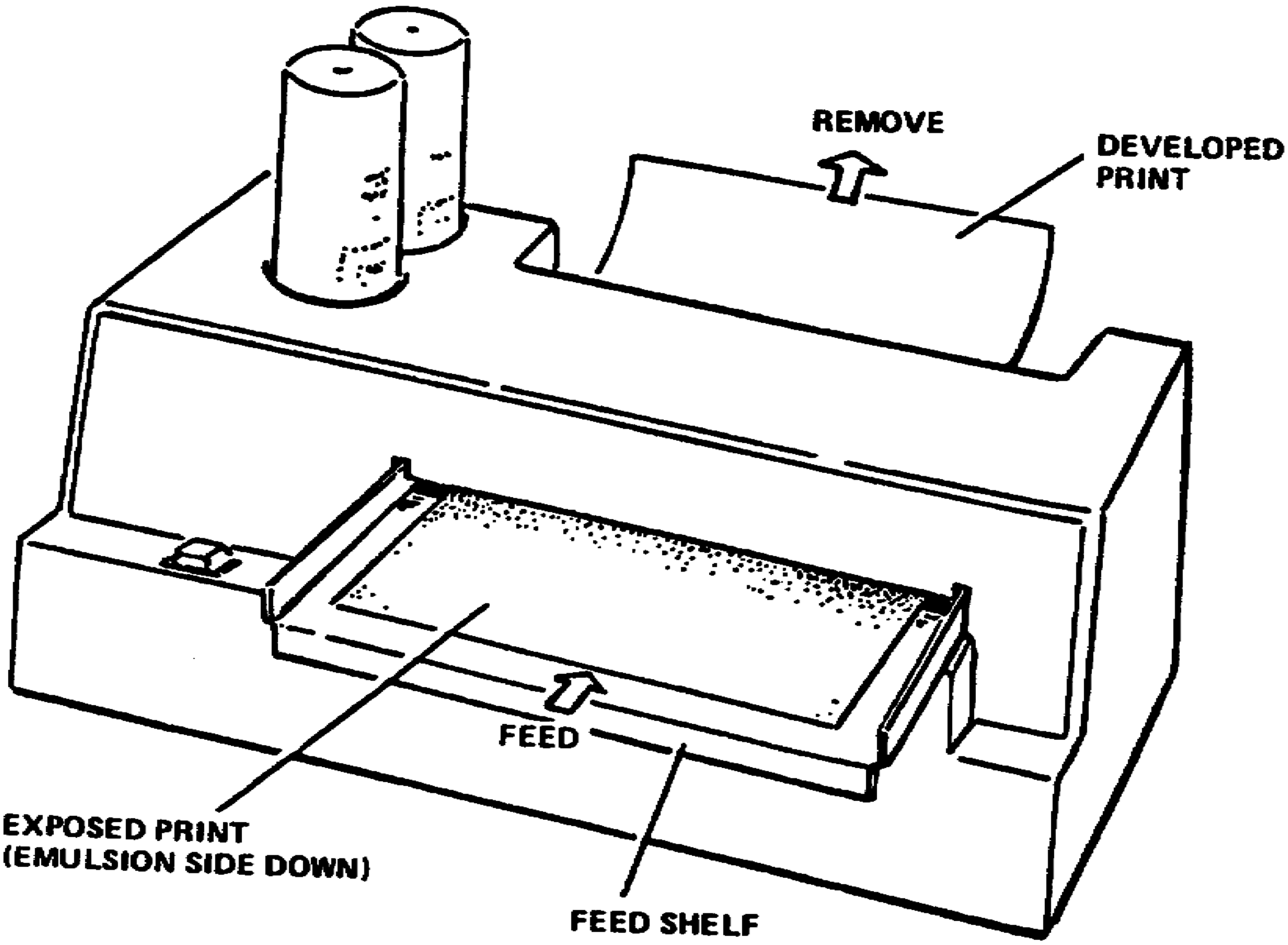


Figure 1-18. Processor complete

(1) Insert all paper lengthwise. <u>Always insert the exposed paper emulsion side down</u>. Do <u>not</u> insert paper that is less than 5 inches in length. All Kodak papers are supplied in sheets and are cut with the long dimension running the long way of the roll. The same orientation should be observed if sheets are cut by the user from larger sheets or from paper supplied in a roll. In this way, all sheets of paper can be handled the same, with one of the narrow edges entering the process first.

> IMPORTANT: Be sure the paper fed into the processor enters the processing rack assembly rollers squarely. With 14-inch wide paper, use the edge of the feed shelf to align the paper squarely with the rollers. For paper widths less than 14 inches, center the paper on the feed tray.

(2) Grasp the leading edge of the print as it emerges from the processor and apply slight tension. Failure to do this may result in a paper jam, or excessive moisture on the trailing edge of the print.

(3) To prevent the lightweight paper from wrapping around the rollers when processing the lightweight or thinner photomechanical paper, stiffen the leading edge of the paper by folding a 2-inch tab, emulsion side to emulsion, straight across the lead edge. Grab the leading edge as soon as it emerges and apply slight tension until the paper is free of the processor.

c. Once the paper is removed from the processor, let it dry for a few minutes. It is ready to go if it is needed for immediate press releases. If you are using the processor for mass production, then fix, wash, and dry the prints.

d. The Army has mass production requirements for accidents, reports, etc. and the Ektamatic processor can save time and provide consistency in the quality of your prints.

LESSON 1
PRACTICE EXERCISE

1. Which chemical process is used for processing color negative film?

   a. EP-2
   b. E-6
   c. C-41
   d. DK-50

2. Which of the following pairs of chemicals represent the two basic groups of photographic chemistry?

   a. Film and Paper
   b. Negative and printing
   c. Positive and Reversal
   d. Color and Black & White

3. When mixing chemistry:

   a. Carefully mix everything together
   b. Always add the water to the chemical
   c. Always add the chemical to the water
   d. Wear a mask because chemistry stinks

4. When film is immersed in a Black and White developer:

   a. A latent image is formed in the emulsion
   b. The silver halides are converted to water soluble salts
   c. Exposed silver halides are converted to black metallic silver
   d. The image must be viewed in white light to insure complete processing

5. Undeveloped film must always be:

   a. Protected from white light
   b. Processed under white light
   c. Handled while wearing gloves
   d. Inspected for possible defects

6. The use of stop bath during processing:

   a. Will prolong the life of the developer
   b. Is an optional step in the processing sequence
   c. Will prevent overdevelopment and prolong the life of the fixer
   d. Will conserve developer by reducing the carryover into the fixer

7. What is the normal development temperature when processing film?

   a. 50 degrees
   b. 58 degrees
   c. 68 degrees
   d. 78 degrees

8. What are the three general types of stop bath?

   a. Plain, water, and acid
   b. Plain, acid, and acid-hardening
   c. Water, acid, and acid-hardening
   d. Water, neutral, and plain

9. When processing at high temperatures use an acid-hardening stop bath:

   a. To harden the emulsion
   b. To soften the emulsion
   c. To preserve the fixer
   d. To retard development action

10. What are the three types of fixing baths?

   a. Plain, water, and acid
   b. Plain, acid, and acid-hardening
   c. Water, acid, and acid-hardening
   d. Water, plain, and acid-hardening

11. Film must always be washed:

   a. To prevent chemistry from contaminating your hands
   b. For short periods of time so water will not be wasted
   c. Because unwashed film may develop stains or fade in time
   d. To make sure all the black metallic silver has been removed

12. How can agitation when processing in daylight tanks be accomplished?

   a. Vigorously shaking the tank to insure even development
   b. Using the automatic mode of the tank agitation machine
   c. Firmly tapping the tank on the edge of the sink 1 or 2 times
   d. Inverting the tank and bringing it back to an upright position

13. What are the three types of paper emulsions?

    a. Bromide, chloride, and chlorobromide
    b. Bromide, chlorox, and chlorobromide
    c. Chlorine, chloride, and chlorobromide
    d. Iodide, chlorine, and chloride

14. Silver halides are suspended:

    a. In the paper base
    b. In the baryta layer
    c. In the emulsion
    d. In the atmosphere

15. Which area of the negative has the least density?

    a. Emulsion
    b. Highlights
    c. Middletones
    d. Shadows

16. Which grade of paper is used to print a normal or average contrast negative?

    a. 1
    b. 2
    c. 3
    d. 4

17. When processing, how is the exposed paper placed into the developer?

    a. Emulsion side up
    b. Emulsion side down
    c. Before placing it in the hypo
    d. After placing it in the hypo

18. When is the Ektamatic printing process ideal?

    a. Professional quality portraits are desired
    b. Water conservation policies are in effect
    c. Archival quality prints must be produced
    d. Prints must be produced in a hurry

19. During the stabilization process:

    a. A stop bath is not required
    b. The activator will neutralize the developer
    c. The stabilizer will activate the developer
    d. Extended wash time produce stains on the print

20. The Ektamatic processor works well for Army mass production requirements such as:

    a. Aerial and reconnaissance photos
    b. Photojournalism and exhibition photos
    c. Portraiture and wedding photos
    d. Reports and accident photos

You should now be familiar with the processing of photographic paper, to include selecting and identifying different types of paper, the tray processing method and processing with the Ektamatic processor. If there is any area you are not sure of, go over it again. If you feel competent in your knowledge of the material, go on to Lesson 2.

LESSON 2
PRODUCE A PHOTOGRAPHIC PRINT

TASK

Perform the procedures for producing acceptable contact and protection prints.

CONDITION

Given information and diagrams about the procedures of producing contact and protection prints.

STANDARDS

Demonstrate competency of the task skills and knowledge by correctly responding to a minimum of 80 percent on the multiple-choice test covering procedures for producing acceptable contact and projection prints.

REFERENCES

TM 11-401
TM 11-401-2

Learning Event 1:
DESCRIBE CONTACT PRINTING

1. Contact printing: A portion of your printing requirements can be satisfied by contact printing. When the print is to be the same size as the negative then contact prints are usually made. Contact prints are made by placing a sheet of photographic paper in direct contact with a negative. When white light is directed toward the negative, the negative image controls the amount of light transmitted to the paper. The dense areas of the negative bar the passage of light, while the clear, or low density areas, permit light to pass freely. The image formed on the sensitized coating of the paper is a reverse of the negative. The result is a positive that approximates the true black and white tonal relationship of the subject.

a. Contact prints are usually made for two different reasons. One, to be used as a final product, and two, to be used to select which negatives will be projection printed.

(1) When contacts are made for use as a final product, they are usually produced from 4- x 5-inch negatives or larger. Because of their large size, the image produced from these negatives can often be used without enlargement. Aerial type negatives ranging from 5 to 9 inches wide commonly require only a contact print as the final product.

(2) When contacts are made for the purpose of selecting which negatives will be projection printed, they are usually made from 35 mm, 120, or 4- x 5-inch negatives. These contacts, commonly called “proof sheets", are very convenient for viewing the contents of the negatives which are available for printing from any particular job or event that was photographed. Proof sheets are routinely produced in most Army photographic facilities.

b. There aren't any special processing requirements for contact printing paper. You can use the standard processing procedure or the Ektamatic processor.

2. Contact printing equipment. The basic requirement for photographic contact printing is to hold the negative and the paper tightly together during exposure to the printing light. For this reason contact printing equipment is needed to maintain firm contact between the negative and paper. Contact prints can be made with a printing frame or with a printer.

a. A printing frame is a simple device involving a wooden or plastic frame, a clear glass face, and a padded spring clamp back. The negative and the paper are held, emulsion to emulsion, between the glass and the back. The negative is placed on top of the paper toward the glass side. For the exposure, the frame is placed with the glass side facing toward the light source, usually a projection printer. The printing frame, or variations of it, are more commonly used in photographic facilities for contact printing negatives 4- x 5- and smaller.

b. Some contact printers used by the Army are quite elaborate. Some have a platen with a pneumatic (air filled) bag (such as the EN-22A). Others use a vacuum platen to assure contact between the negative and the sensitized material. A handle-operated switch automatically turns on the exposure lights when the platen is brought into position and locked.

c. The actual number of printing lamps in a single printer may be as great as 176. Each lamp is connected to an individual switch, permitting various numbers and combinations of lights to be turned on or off. In addition to the exposing lights, contact printers are equipped with safelights and white (viewing) lights. A typical Army contact printer is shown in Figure 2-1.

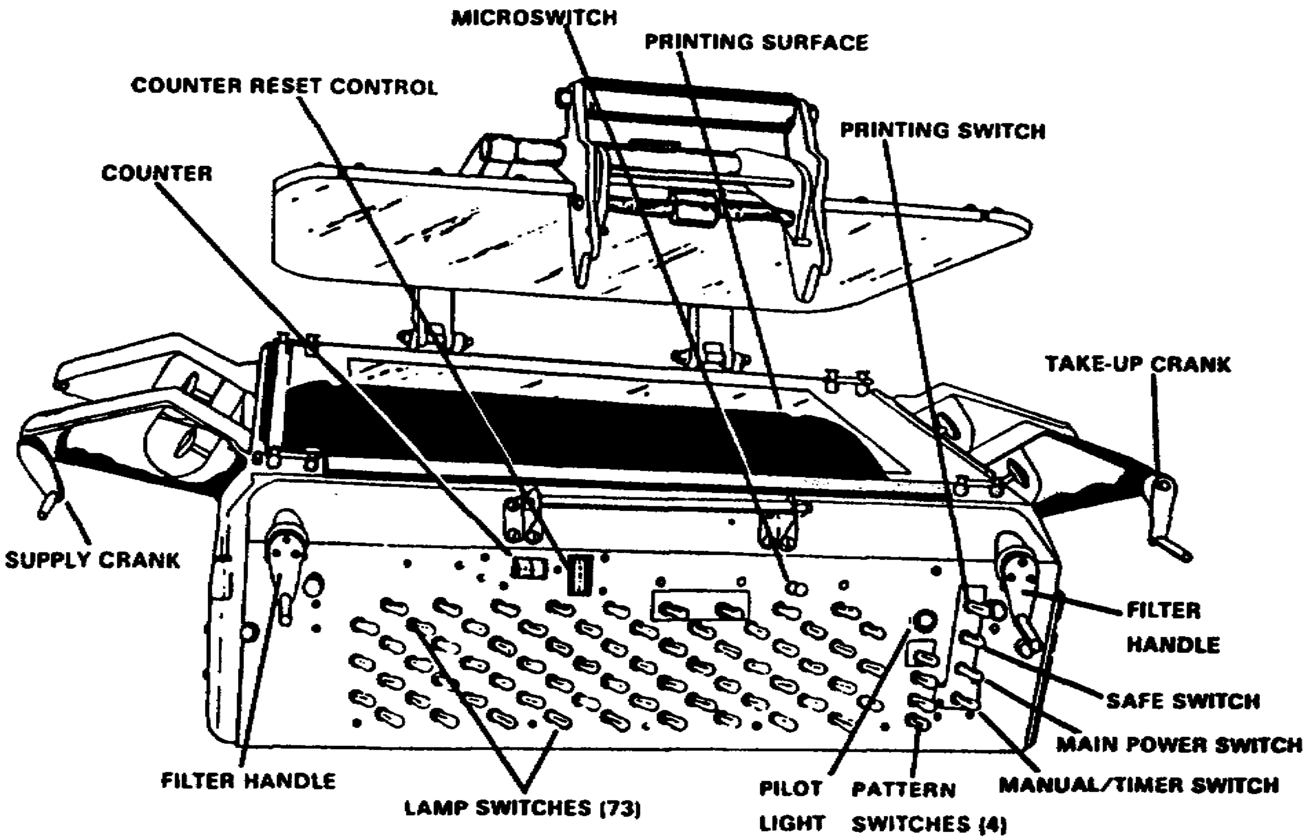


Figure 2-1. Photographic contact printer EN22A

d. The EN-22A is a self-contained printer that accommodates negatives up to 9- x 18-inches and aerial roll film, supported by brackets, up to 9.5 inches in width and 500 feet in length. Other characteristics of this printer are as follows:

(1) It has 73 incandescent/argon printing lights. Each light can be individually controlled. There are also pattern switches to control groups of lights. This type of control permits dodging (holding back light from an area) and burning-in (adding more light to a given area) of the image.

(2) In the EN-22A contact printer, print contrast is controlled through the use of a built-in filter roll. The roll is divided into segments, each of which passes a different color of light (comparable to the color of light produced by filters contained in a set of variable contrast filters). By turning a crank on the outside of the contact printer, the appropriate portion of the roll of acetate filter material can be placed between the light source and the printing surface. There is a section of clear acetate for printing without a filter.

(3) Automatic exposure times can be set from a fraction of a second to several minutes by means of a timer attached to the printer.

(4) In addition, most printers are equipped with a sheet of diffusing glass, located between the lights and the negative when the lights are turned on. Above the diffusion glass is a thick sheet of plate glass on which the negative is placed, emulsion side up.

3. Contact printing steps: the procedure for making contact prints depends on the type of equipment used in the process.

a. The contact printing procedure using a contact frame is as follows:

(1) Clean the printing area before starting other operations. Remove all dust, lint, dirt, and other foreign matter from the printing area. When possible, use a vacuum cleaner, as dusting causes the material to become airborne, and it soon settles back into the working area.

(2) Connect the projection printer to the timer. Turn the printing light on and make sure the area illuminated by the projected light is large enough to cover the entire printing frame as shown in Figure 2-2. Allow a generous coverage of light in case you misalign the printing frame.

(3) Clean the negative to be printed, making sure it is free of all dust and lint.

(4) Place the negative with the emulsion side up on the face of the printing frame's glass surface. For a professional appearance, when contacting more than one negative or strip of negatives on the same sheet of paper, be sure the subject matter is facing the same direction. With roll film there is a frame number located below each negative. When the negatives are positioned on the glass, the lowest numbered negative should be located in the upper right corner. The highest numbered negative (last frame of the roll) should be in the lower left hand corner. Since the film is placed on the glass emulsion up these numbers will appear backwards when viewed from this position. Refer to Figure 2-2 for an example of the proper placement of the negatives.

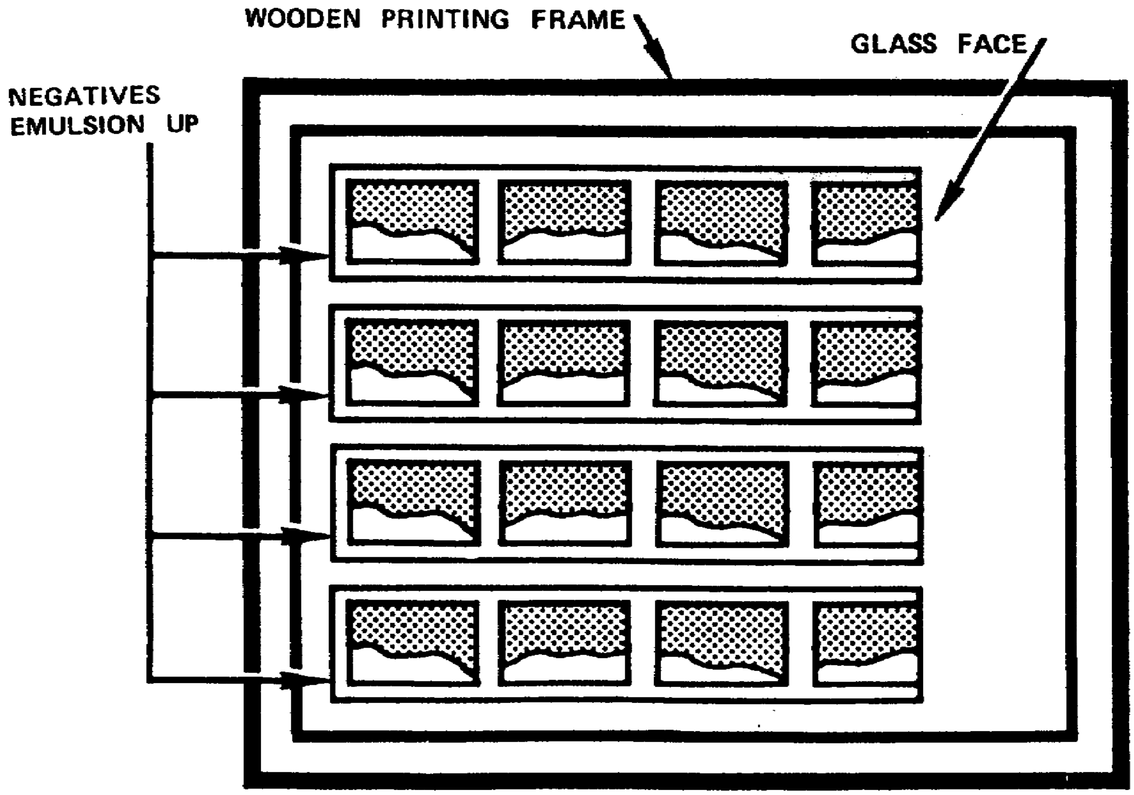


Figure 2-2. Printing frame

(5) Turn off all white room lights. Use only the correct safe lights.

(6) Judge the contrast of the negatives. If you do not have the ability to judge contrast, start out by assuming that the negatives have normal contrast.

(7) Decide what contrast filter must be used. As in the above step, if you cannot judge the contrast yet, assume that a medium contrast filter will do the job. Position the correct filter on the printer, and then select a sheet of variable contrast paper. Now you are ready to make a test strip. (If you are using graded paper then don't worry about the contrast filters).

b. The procedure for making a contact printing test, using a printing frame is as follows:

(1) With your negatives placed on the printing glass, you are now ready to make a test exposure. Place the photo paper, emulsion down, on the negatives.

(2) With the paper in place, raise the padded back and clamp it down securely on the glass so the negatives and paper are in direct contact. Now flip the frame over so the glass side is facing up at the projection printer.

(3) Now you are ready to make the first exposure. Start by giving the entire sheet of paper a two-second exposure.

(4) Next, cover a portion of the paper approximately 1 to 2 inches wide with a piece of cardboard or other opaque material, and make another exposure of two seconds. A sample of this procedure is shown in Figure 2-3. Repeat this procedure to make as many exposures as needed to bracket the correct exposure.

(5) After development, there are, on one sheet of paper, five bands with exposures of 2, 4, 6, 8, and 10 seconds. From this test you should easily be able to determine the correct exposure time.

(6) Inspect the test strip. Determine the best exposure by observing any of the highlight areas. The highlight areas should be slightly darker than the base of the paper that didn't receive any exposure. The highlight areas should contain detail. Too much exposure is indicated when the highlight areas are much darker than unexposed material. If the highlights are not correct on any of the test strips, run a new series of tests using more or less exposure as indicated.

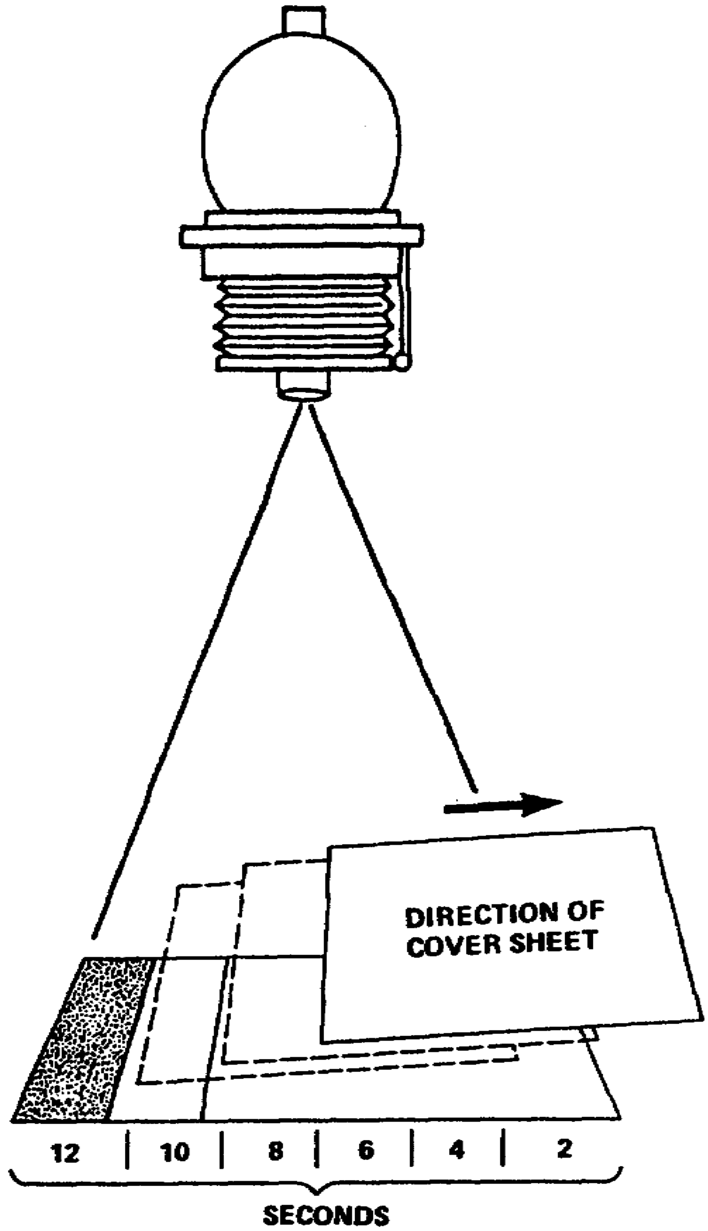


Figure 2-3. Making a test strip

(7) When the best exposure has been selected, determine if the correct contrast exists. Do this by examining the show area of the test strip that has the correct highlight exposure. If the show area of this test is too light, the print does not have sufficient contrast. If the show is too dark, the print has too much contrast.

(8) After completing the necessary test and corrections, you should be able to make good contact sheets.

c. The procedure for making contact prints, using a printer such as the EN-22A, is quite different from that described in paragraphs a and b. Listed below are the steps involved when using a contact printer.

(1) Clean the printing area.

(2) Connect the timer to the printer and then to the proper receptacles. Place all the printing light switches in the ON position. Check the viewlights and the safelights in the printer for proper operation. Place the master switch in the OFF position and check the operation of the platen-actuated pushbutton switch.

(3) Clean the negative(s) to be printed.

(4) Place the negative(s) with the emulsion side up on the glass of the printer.

(5) Turn off all white room lights.

(6) Judge the contrast of the negative.

(7) Select the proper filter and you will be ready to make a test strip.

d. The procedure for making a test strip is as follows:

(1) If you are making a contact of only one negative such as a 4- x 5-inch, then cut a sheet of paper into test strips approximately 2 inches wide.

(2) Choose the area of the negative to be used for exposing the test strips. The area for the test should contain highlights, middle tones, and shadows. The same part of the negative should be used to make each test strip.

(3) Make a series of test exposures using a normal contrast filter. Use a systematic method of exposing. For example, you can start with 2 seconds and double it each time, or another method is to expose each test with an equal amount of increase. The idea here is to bracket the correct exposure; that is, to go from underexposure to overexposure.

(4) Inspect the test strips and determine the best exposure.

(5) When the best exposure has been selected, determine if the correct contrast exists.

(6) If necessary, run a new series of test exposures with a different contrast filter.

4. Controls in contact printing. Since any number of prints may be made from one negative, and the results can be varied by exposure and light dodging, it is possible to correct errors that may exist in the negative. To use correction measures successfully, you must have an extensive knowledge of both the materials and the procedures that are available to you. Starting with only an average or even below average negative, it is possible to make good photographs in the laboratory. If you know how to use printing controls, it is possible to improve the appearance of the final print.

a. Many camera exposures are made under less than ideal conditions and may result in wide variations in density in different areas of a single negative. That is, the exposure in one area is greater or less than that in other areas of the negative. Because of a wide variation in tones or reflective qualities of the subject as a result of poor lighting on the subject, this is often unavoidable. Since the objective of photography is to produce an accurate, detailed representation of the subject, such negatives require special treatment.

b. If you expose the print long enough to bring out detail in the highlight areas, but the shadow areas become overexposed or if you expose a print of the same negative for a short enough time to bring out the detail in shadow areas, but the highlights are underexposed and show no detail, then a corrective action must be taken. This action is referred to as dodging. If only a straight print is made, detail will be sacrificed in the highlights or the shadows, or possibly both areas. Dodging is controlled exposure in specific areas of a print, giving one area less exposure than another.

c. Dodging techniques are varied according to the type of printing that you are doing. Two of these methods are described in the following paragraph:

(1) The easiest method to use for the EN-22A is to turn out individual lights under parts of the negative that print too dark. This leaves the lights burning under the areas of the negative that have greater density and gives these areas of the print more exposure. If turning the lights off for the entire exposure time lightens these areas too much, they may be extinguished for only a portion of the total printing time. If turning the lights off for the total printing does not hold the light back enough, the lamps surrounding the thin areas of the negative may have to be turned off in addition to those directly below the thin area.

(2) For contacts made from a projection printer, dodging can be accomplished by placing a translucent medium between the light source and the negative. Material, such as tissue paper, can be torn in the approximate shape and size of the thin area of the negative. During the exposure, the material must be kept in constant motion or well-defined areas in the shape of dodging material will be apparent in the print. The increased density in this portion of the diffuser reduces the light in that area.

d. Do not attempt to change the overall contrast by excessive dodging. Overall print contrast should be altered by changing the contrast filter.

You should now be familiar with the methods and procedures used in contact printing. If there is any area you are not sure of, go over it again. If you feel confident in your knowledge of the material, go on to Learning Event 2.

Learning Event 2:
DESCRIBE PROJECTION PRINTING

1. Projection printing. Projection printing differs from contact printing in that the negative is separated from the photo paper - the image on the negative is projected by means of incandescent light through a lens onto the photo paper. By changing the lens to paper distance it is possible to reduce, maintain, or enlarge the image.

a. If the machine can make reductions (images smaller than the negative) as well as enlargements then, technically, it is called a “projection printer". If the machine only makes enlargements from the negative then it is called an “enlarger". Because most projection prints are made at an enlarged scale, it has become common to refer to projection prints as “enlargements" and to call a projection printer an “enlarger".

b. Skill in projection printing is very important to the photographic specialist. As you will discover, projection printing offers many advantages over contact printing. The main advantage of projection printing is that the size of the prints can be regulated regardless of the size of the negative. Other advantages are the ability to improve perspective, the ease of dodging and burning in, and the many and varied special effects that can be employed.

2. Manually operated projection printers. In general, all projection printers are similar in their basic design and operation. They consist of an enclosed light source, a negative carrier, a lens, a means of adjusting lens-to-negative and lens-to-paper (also called lens-to-easel) distances, and an easel for holding the photo paper.

a. It is necessary to have some way of changing the lens-to-paper distance to provide for different degrees of enlargement or reduction. To focus the image on the paper, a means to alter the lens-to-negative distance must be provided. A typical projection printer is shown in Figure 2-4. Refer to it as you study this material.

b. The major components of a projection printer are as follows:

(1) A tungsten bulb is used as a light source. The lamp is enclosed in a light-tight housing, which is ventilated to prevent excessive lamp heat from damaging the negative.

(2) A negative carrier is two metal or plastic plates with an opening in the center large enough to accommodate the negative. The negative is placed between these plates and is held in position by its edges.

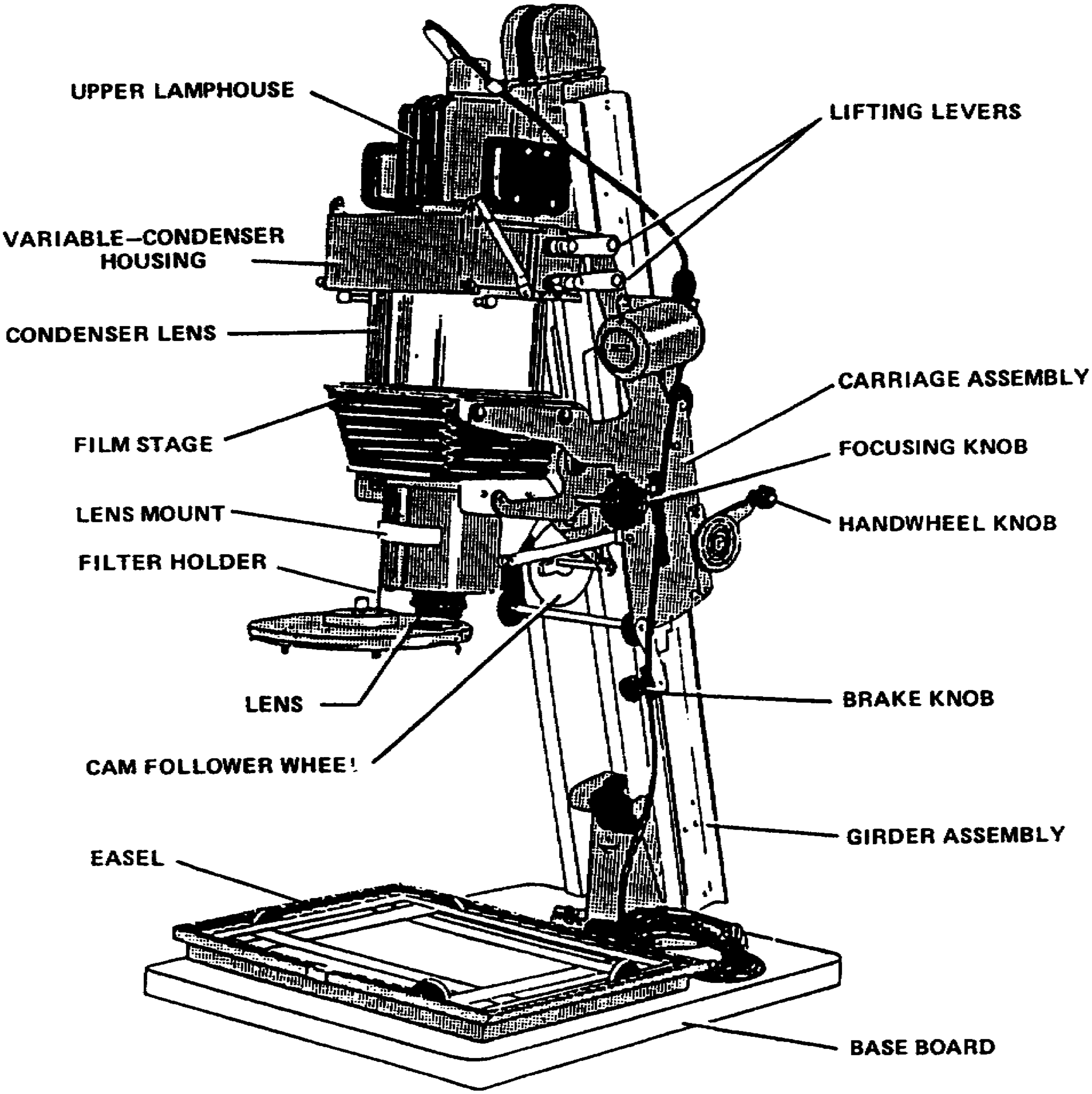


Figure 2-4. Typical projection printer

(3) A bellows should be capable of extending to at least twice the focal length of the lens. This amount of bellows extension is necessary to produce 1:1 (same size) reproductions. The bellows also plays a role in focusing the image on paper.

(4) A lens. The focal length of the lens should cover the angle of field of the negative being printed. A general rule of thumb is to use a lens whose focal length equals or exceeds the diagonal measurement of the negative being printed. The following is an example of the proper lens to be used with the three most common negative sizes.

(a) 35 mm negative uses a 50 mm lens.

(b) 120 negative uses a 105 mm lens.

(c) 4- x 5-inch negatives require a 150 mm lens.

(5) An easel. There are many types of easels in use, each serving the same basic purpose; to hold the printing paper in a flat plane.

c. There are, basically, two types of projection printers, the condenser type and the diffusion type, as shown in Figures 2-5 and 2-6.

(1) The condenser type projection printer (fig 2-5) has a set of condensing lenses between the printing light and the negative. These condensing lenses align and project the light rays evenly through the negative. The condenser type printer produces more contrast and a sharper image from a negative, than the diffusion type printer. As a result, any defect in the negative (dust, lint, scratches, etc.) are faithfully reproduced. In addition, scars, acne, wrinkles, etc. will be very sharp and readily noticeable in the print.

(a) Condenser lenses are designed and ground to provide maximum image sharpness when used with a given focal length lens. Therefore, if you change projector lenses, you must also re-position the condensing lens.

(b) The proper position for use with the different lenses is indicated on the inside flap of the variable-condenser housing.

(2) The diffusion type projection printer (fig 3-5) has a diffusing medium (usually translucent glass) between the light source and the negative to spread the light evenly over the entire surface of the negative. Light emitted from the lamp, as well as that reflected from a parabolic reflector,

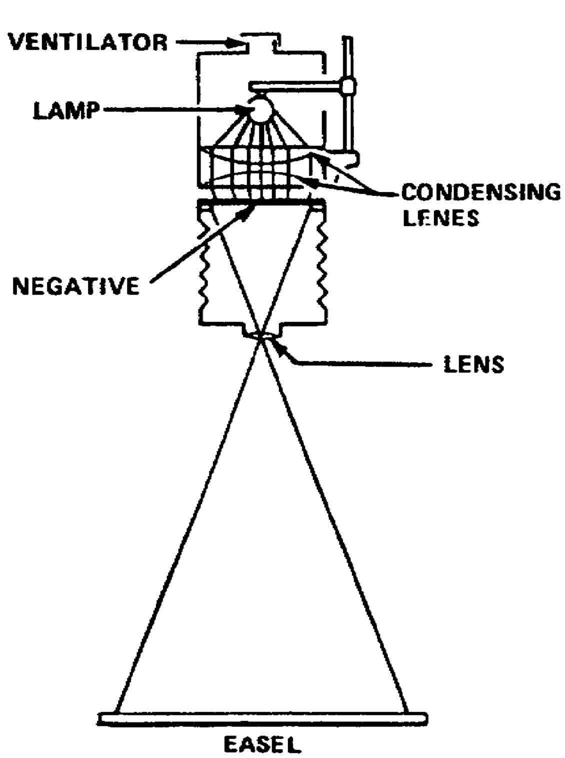


Figure 2-5. Condenser type projection printer

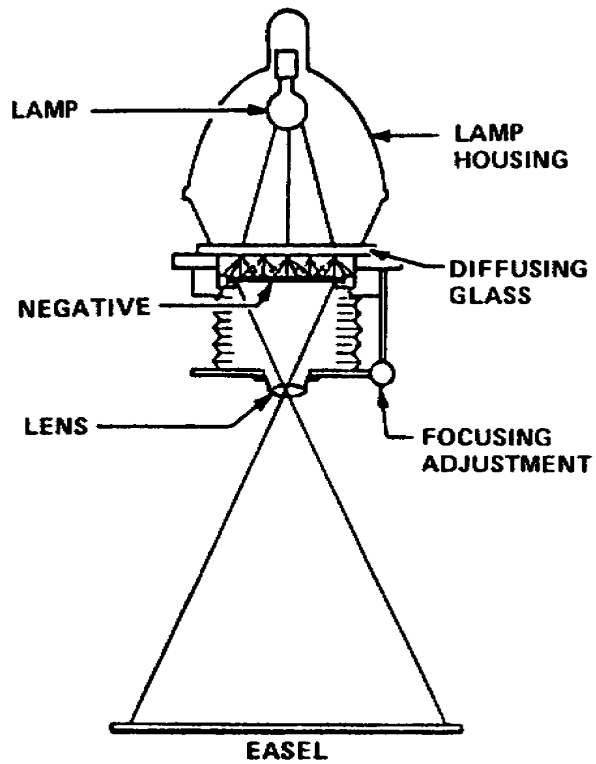


Figure 2-6. Diffusion type projection printer

strikes the diffuser, which in turn, scatters it in all directions. When the light reaches the negative, it is traveling in a nondirectional pattern. The effect of using diffused illumination is that minor negative defects are not clearly recorded on the print. There is a general softening of the image sharpness and this is accompanied by a reduction in image contrast. These characteristics make the diffusion printer very popular for use with portrait negatives.

3. Printer and easel adjustment (composition). It is necessary, before making an exposure on the paper, to compose your image before making an exposure on the paper, to compose your image on the portion of the easel frame which corresponds to the image size you are going to use (4- x 5-inch, 5- x 7-inch, 8- x 10-inch). Follow the steps listed below to make the adjustment.

a. Place the negative in the carrier, emulsion side down. Replace the negative carrier in the projection printer and make sure that it is properly seated.

b. As an aid for composition and to accurately focus the image, place a sheet of white paper in the printing position on the easel. The base side of a finished print serves nicely for this focusing screen. Turn out all white light. Turn the printer light on and open the lens to its maximum aperture.

c. Focusing and arranging the composition of the projected image should be accomplished with the lens wide open for two reasons. First, the brighter the image, the easier it is to see for accurate focusing. Second, stopping down the lens after focusing, increases the depth of field providing a margin of safety for any slight error in focusing.

d. To bring the image to the desired size, the printer head is raised or lowered until the approximate size is reached. The image is then brought into sharp focus. At this point, you are faced with several minor problems. Take a moment and study the image carefully. Most printing papers are rectangular in shape; therefore, you must decide whether to use a vertical or horizontal format. In many cases, the manner in which the scene is composed on the negative is the controlling factor. However, many photographs can be improved in printing by suitable cropping, straightening, or tilting. If the cameraman made no attempt to compose the picture on the negative, you can often enlarge and print the portion of the negative that contains a good picture.

e. Since photographs have infinite variety, and personal likes and dislikes differ, there are no hard and fast rules in composition. However, here are some suggestions that can be used to produce a composition that is pleasing to most people.

(1) Mask off unneeded detail at the edges of the picture. Many times the foreground is fuzzy and is cluttered with objects that distract attention from the center of interest.

(2) Never place the center of interest in the middle of the print. Place it slightly to the left or right of the center, and a little above or below the center line.

(3) Horizontal, vertical, or diagonal lines should never be allowed to cut the picture in equal parts. For example, the horizon should be below or above the center of the picture.

(4) The horizon should be truly horizontal.

(5) Live subjects should be looking into the picture, not out of it. In other words, there should be more space in front of the figure than behind it. This also applies to action photographs. Your composition will be strengthened if the action leads into the photograph and weakened if it leads out of it.

f. Figure 2-7 shows some examples of cropping for composition.

4. Test exposure. With the negative in the enlarger and your composition set, your next step is to make a test exposure. The procedure for making a projection test exposure is the same as used in contact printing.

a. First, the entire sheet of paper is given a two-second exposure. Second, cover all of the paper except a portion approximately 1/2 inches wide with a piece of cardboard or other opaque material, and make another exposure of two seconds. Uncover an additional 1/2-inch strip and make another two-second exposure. Repeat this procedure to make as many exposures as are needed to bracket the correct exposure. After development there are, on one sheet of paper, several bands with exposures of 2, 4, 6, 8, etc. seconds. From this test, you should easily be able to determine the correct printing time.

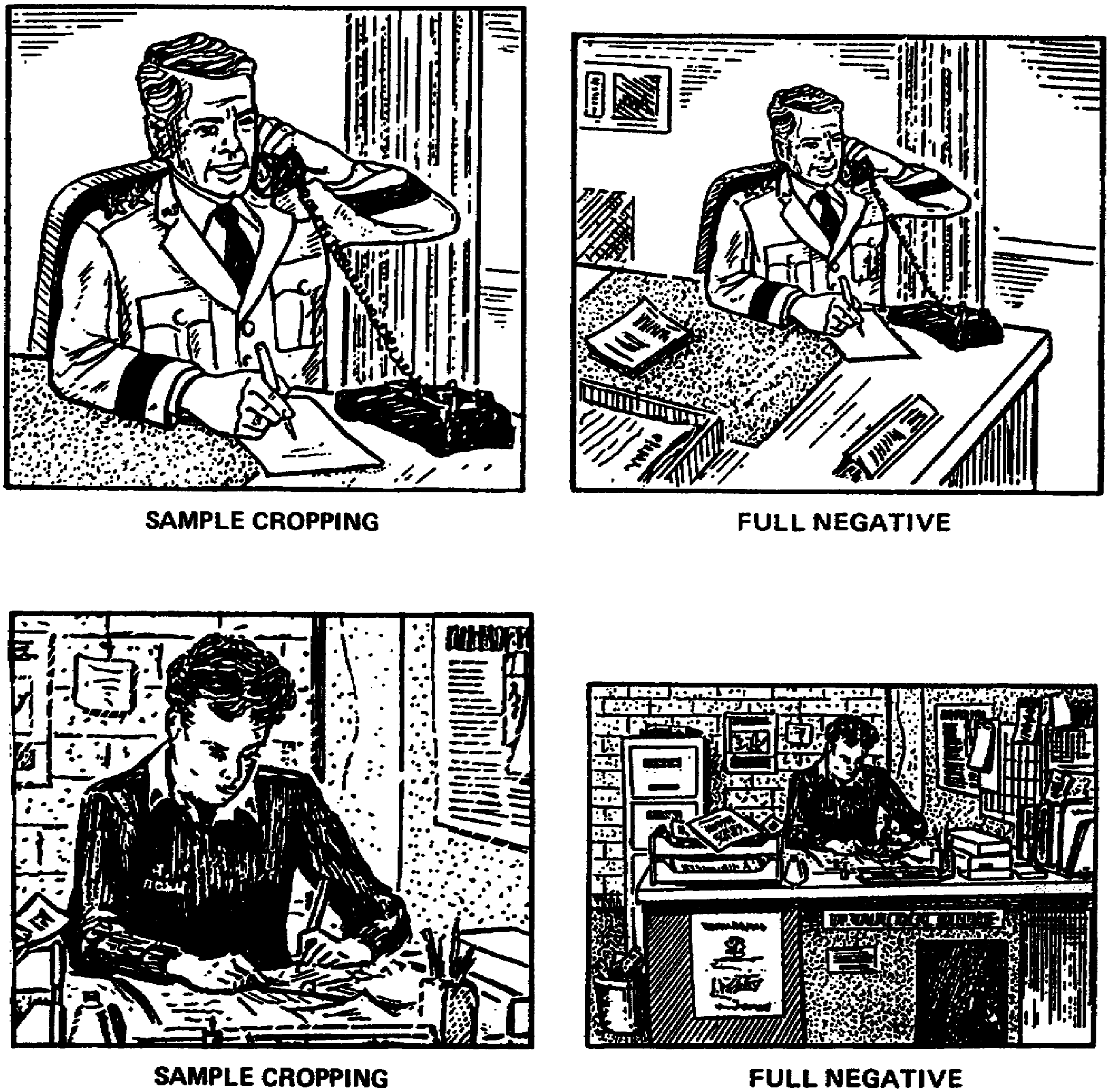
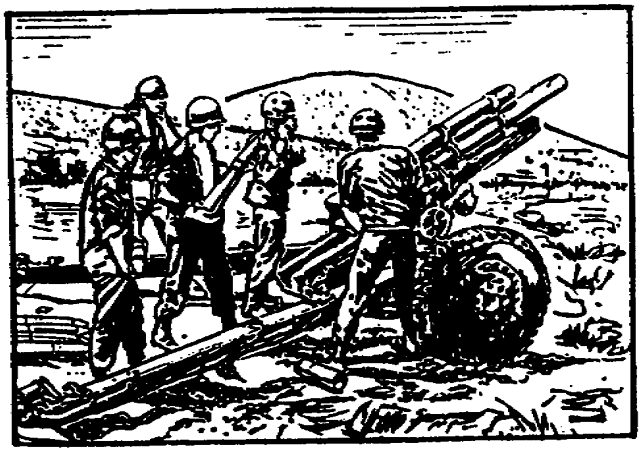
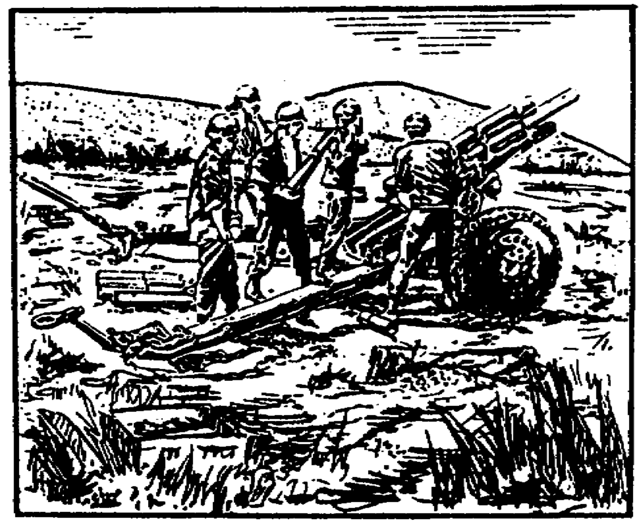


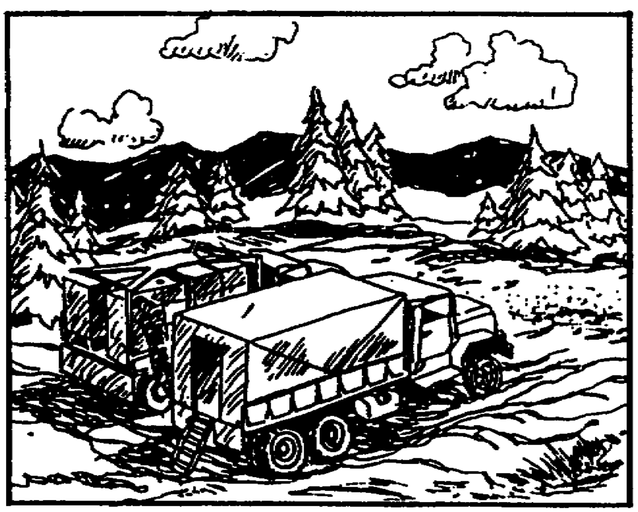
Figure 2-7. Sample photos



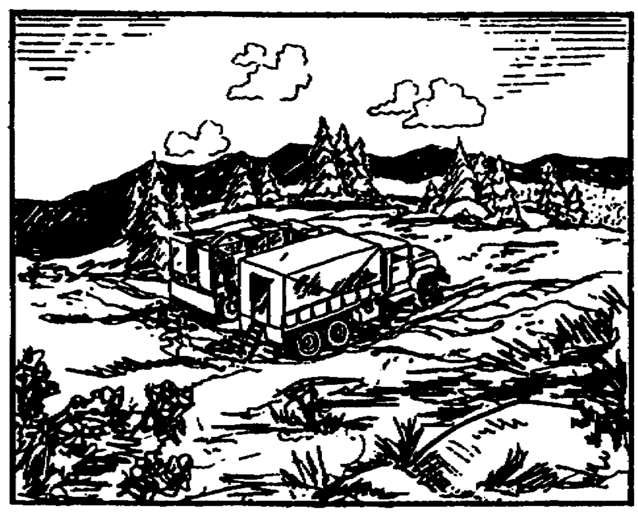
SAMPLE CROPPING



FULL NEGATIVE



SAMPLE CROPPING



FULL NEGATIVE

Figure 2-7. Sample photos (continued)

b. Process the print normally. After the test print has been in the fixer for a couple of minutes, it may be removed, rinsed in fresh water, and inspected under white light to determine which of the test exposures is correct. If none of the exposures appear to be normal, the correct exposure may fall between two of the exposures. For example, the six-second exposure may appear too light and the eight exposure may appear too dark. This would indicate that you should use seven seconds of exposure time. A good example of a test print is show in Figure 2-8.

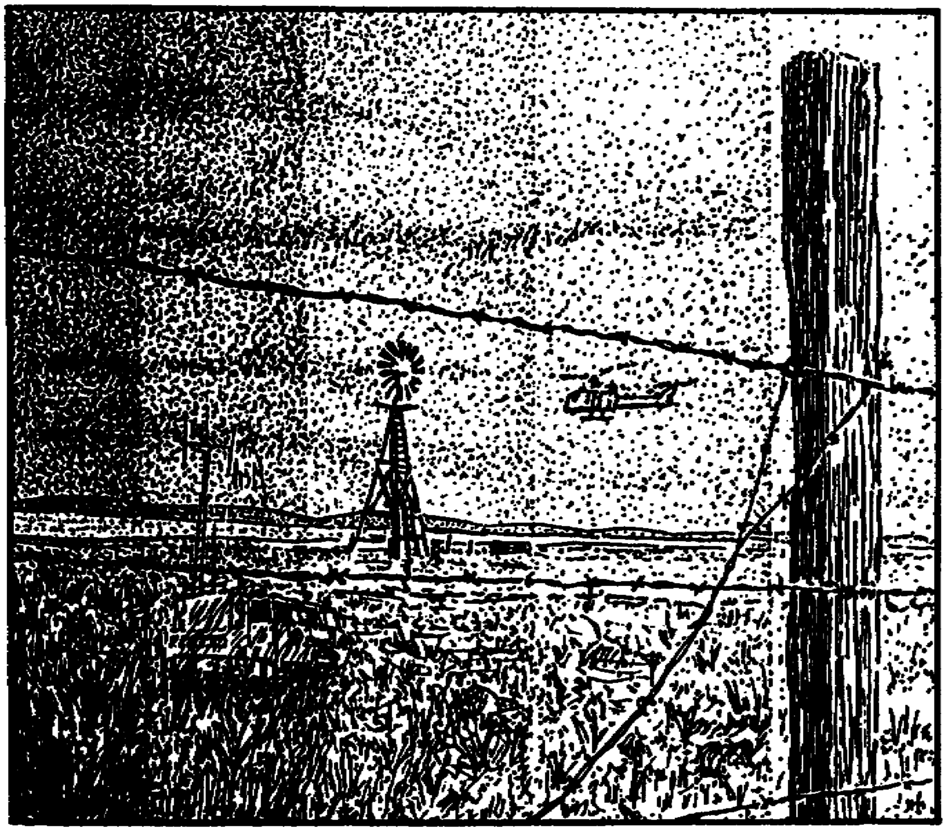
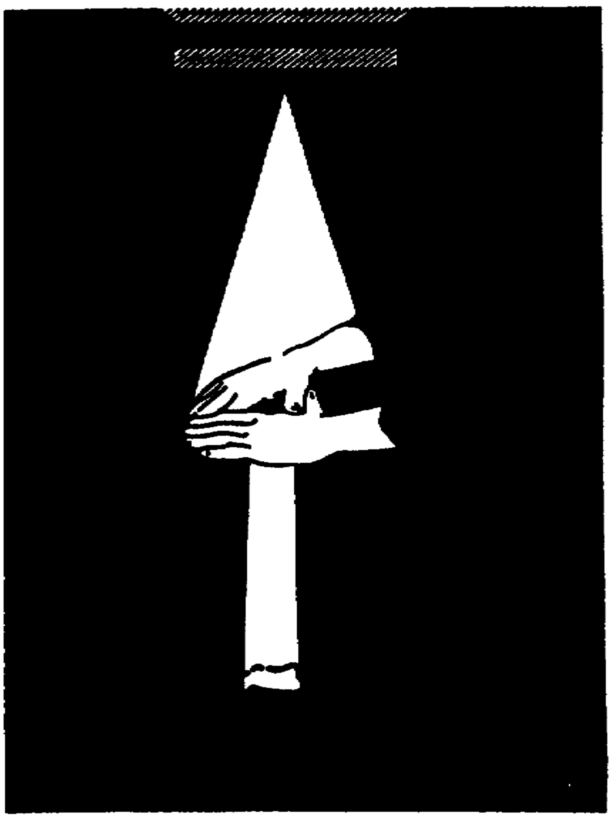


Figure 2-8. Test print

c. What about contrast? A good print usually has a white somewhere in the highlight area, a black in the deepest shadow, and a scale of grays between these two tonal extremes. Generally, if the highlights and middle tones are correct, but the shadows areas are too light, then you should increase the contrast. If the highlights and middle tones look good but the shadow areas are too dark, then decrease the contrast. If you have doubts about the proper contrast, make additional prints using different filters or different grades of paper, whichever may apply. Inspect the group and then decide which print has the most pleasing or realistic contrast.

5. Local control of exposure. As stated earlier, projection printing permits a great deal of print control.

a. In some instances, the range of brightness values in a photo may be too great to be reproduced in a straight print. However, adequate compensation can usually be made by shading the area which prints too dark. For example, detail in shadow areas can be preserved by dodging (holding back the light) during part of the exposure. Dodging can usually be accomplished more easily and accurately in projection printing than in contact printing.



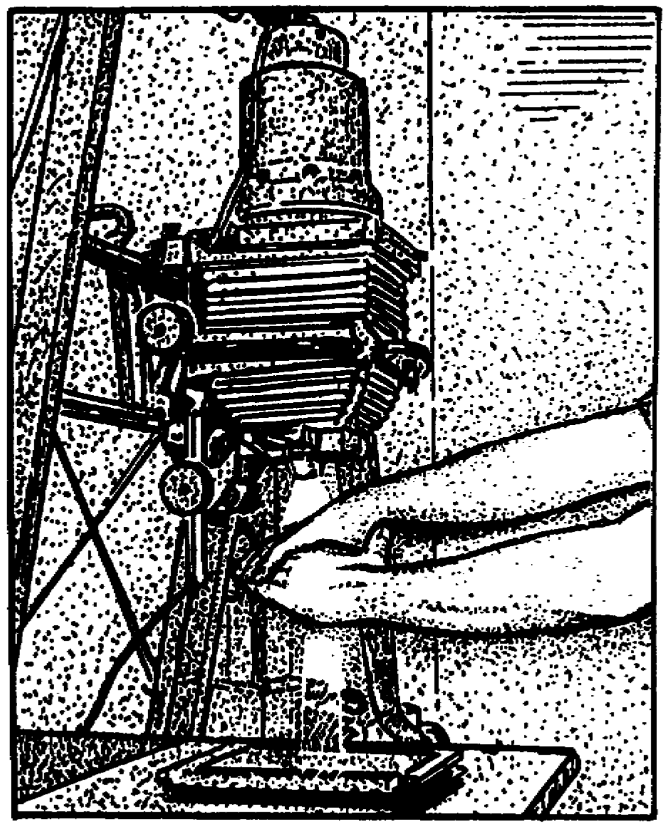


Figure 2-9. Using the hands as a dodging device

b. Since the dodging material is held and manipulated in the beam of light between the lens and paper, its location and coverage can be seen and controlled during the printing exposure. As shown in Figure 2-9, the dodging device may be nothing more than your hands. It is surprising how many shapes you can form with your hands.

c. Or, as shown in Figure 2-10, a dodging device can be made by placing an opaque, properly shaped piece of material on a wire handle. The shape of the dodging tool should approximate the shape of the image area to be lightened. It should also be slightly smaller than the area to be dodged. This is necessary because as the tool is moved further away from the paper, the area covered by its shadow increases. Although dodging is generally necessary for only part of the exposure time, the device used must be moved up and down slowly and constantly to blend the areas receiving various exposures together, thus preventing a sharp line between the area dodged and the other parts of the image.

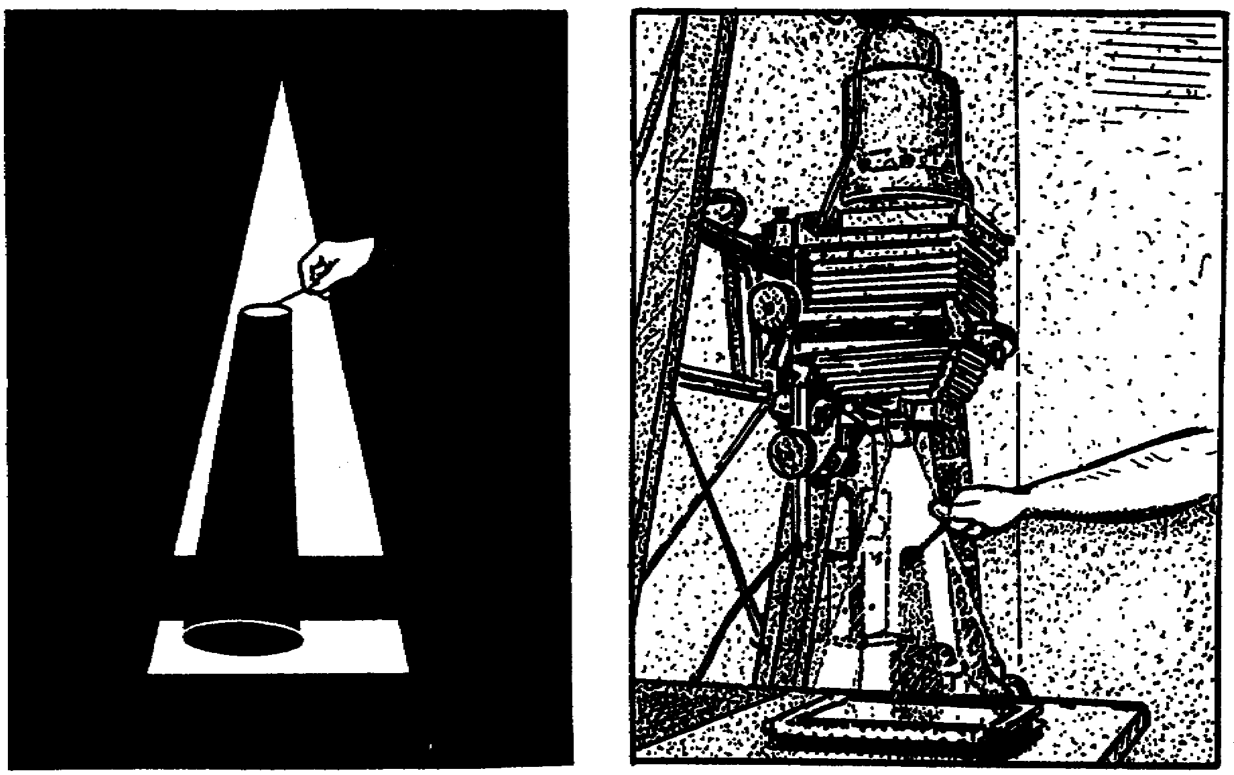


Figure 2-10. Using a wire-supported dodging device

d. Another form of print control, burning-in, is used to make an area darker. This is done by using a piece of cardboard or paper with a hole cut in the center that is smaller, but approximately the same shape as the area to be burned in. The device used for this procedure need not be complex. Figure 2-11 shows a sample device in use. After the normal overall printing exposure has been made, the burning in device is moved into position between the lens and the easel. The card holds back all the light except the light passing through the hole to the area that needs additional exposure. As in dodging, this device must remain in motion during the exposure to prevent a sharp outline of the hole.

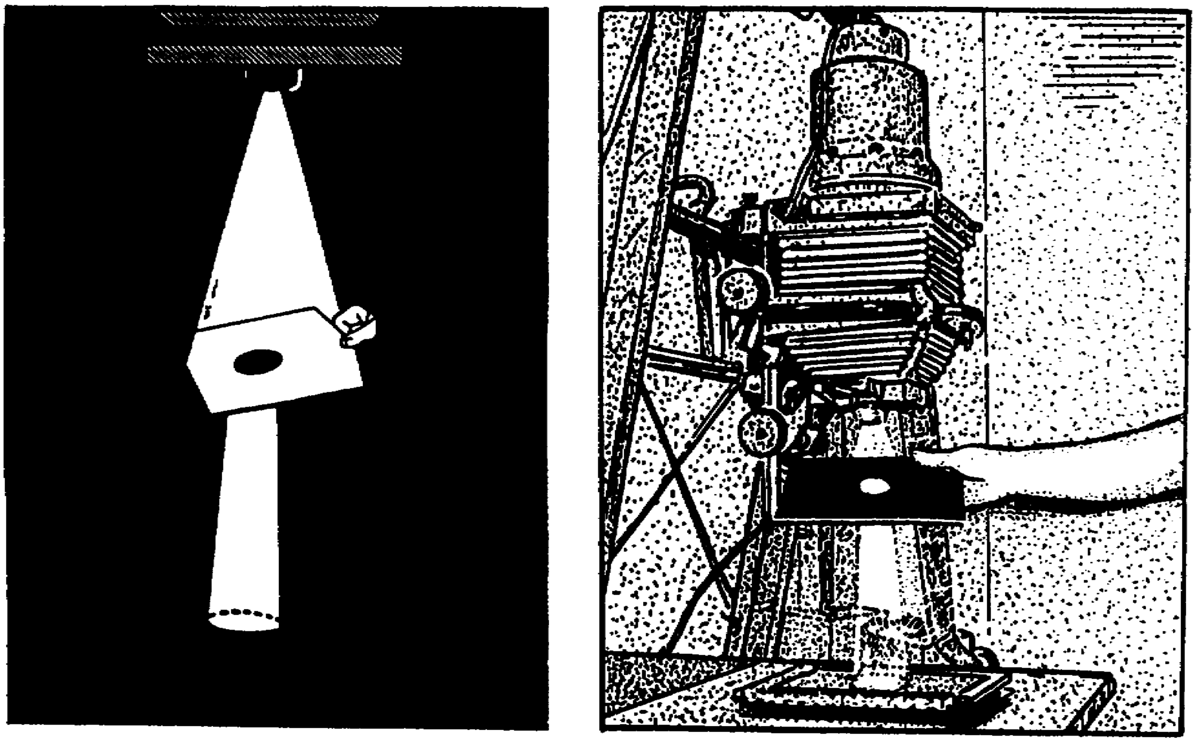


Figure 2-11. Using a burning-in device

e. Remember the amounts of time that you used for each step in the printing exposure. This is the only way in which the procedure can be controlled well enough to be duplicated for additional prints. Write the exposure on the back of the negative jacket. For example, 10 seconds overall exposure, 3 seconds dodge facial area, and 8 seconds burn in the sky.

f. As you gain experience in the dodging and burning in techniques, you will also develop your ability to "read" a negative. That is, by observing the negative, you can judge the amount of dodging that is necessary without having to make a test exposure. Before you develop the ability to "read" negatives, you should use test strips. You can use a small test strip to determine the printing time for the area to be dodged or burned in. To do this, you simply place the test strips over the desired area and make the test exposure. This will aid you in determining the time needed to properly expose this particular area of the negative. This use of the test strip will greatly reduce the waste of valuable paper.

6. Distortion control. Many cameras have no means of perspective control. As a result of these limitations, many negatives are made which show the bottom of buildings as being very wide and the tops of the buildings as being very narrow. This is not the normal view as we would see it. This places the burden of correcting perspective on you and your lab knowledge.

a. Certain kinds of perspective can be corrected through the use of a projection printer. This control is based on the fact that the farther the easel is from the lens, the larger the image will be. If the image is projected on a tilted plane, that portion of the image farthest from the negative will have the largest image size. If the negative consisting of parallel lines were to be projected onto a tilted plane, all portions of the negative would converge, or not be recorded as parallel. By the same token, a negative that has lines which are not parallel (within limits) could be projected so that the print will show them as parallel. As an example, suppose you must print a photograph of a tall building and, because of a lack of controls on the camera, it was necessary for the photographer to point the camera upward. This will cause the building to appear wider at the bottom than at the top, or make the building look as though it were leaning backwards.

b. This can be corrected in projection printing by tilting the easel so the top part of the building is farther from the printer lens than the bottom of the building, as shown in Figure 2-12, thus restoring the vertical lines to their correct position. Figure 2-13 illustrates a building as it would appear before correction, and the effects of tilting the easel during printing.

c. When a projection printer is used with a tilted easel, use a very small f/stop to maintain sufficient depth of field and keep the entire image in focus. For best results, focus for the center portion of the picture, and then stop down the diaphragm until the sides of the picture are brought into focus.

You should now be familiar with the procedures used to obtain quality projection prints. If there is any area that you are not sure of, go over it again. If you feel competent in your knowledge of the material go to Learning Event 3.

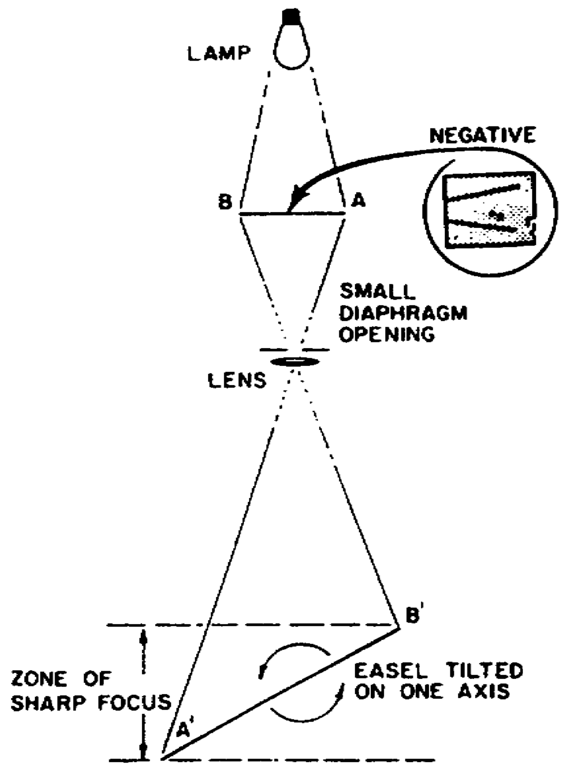


Figure 2-12. Correction by tilting the easel

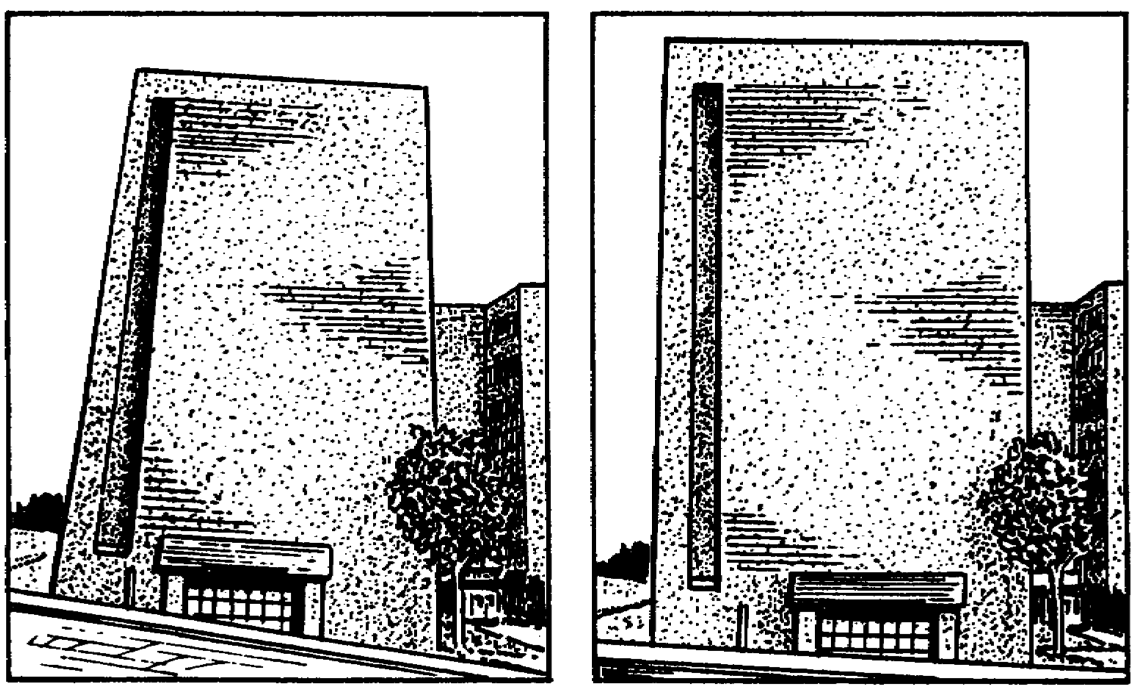


Figure 2-13. How to control vertical perspective

Learning Event 3:
DESCRIBE PRINT FINISHING

1. Print Spotting. Spots may be caused by materials sticking to the negative during printing, by abrasion of the emulsion, by emulsion defect, by negative spotting, or by excessive density in small areas of the negative. The removal of these marks is called print spotting. In prints, defects range in tone from white to black and the technique for removing them varies according to the tone of the spot, the surface of the paper, and the medium used to darken the area. Any print surface from glossy to matte can be spotted.

a. Spotting glossy prints. Most prints require some spotting even if it is just to cover up minor dust spots. Spotting is sometimes used to correct or tone down certain areas. Highlight areas which appear too bright in the print may be difficult to remove from the negative with an etching knife; but if they are small, these areas can be toned down by spotting. Glossy paper surfaces, especially ferrotyped surfaces, cannot be spotted with lead pencils without first applying retouching fluid to the surface, to provide a rough surface for the lead to cling to. Apply the retouching fluid to the spot using a cotton swab; and when the surface is dry, fill in the spot with pencil until it can no longer be seen at the normal viewing distance. The selection of the correct pencil is very important. The lighter the spot and the darker the area surrounding it, the softer the lead must be. For example, a white spot in a highlight area should cover easily with a 3H pencil; however, a white spot in a gray area might require a 3B or softer pencil.

b. Spotting semi-matte and matte prints. Prints that are not glossy are usually either semi-matte or matte. A semi-matte print has a very slight gloss, while a matte print is completely without gloss. The luster surfaces, smooth luster, rough luster, silk, linen, crystal, etc., come under the general classification of semi-matte. Some of the semi-matte surfaces are so smooth that they very nearly approach the surface of unferrotyped glossy paper. If there are white spots on a dark background on prints of these surfaces, they may have to be spotted, using the same retouching fluid and techniques as for glossy prints.

c. Spotting matte prints is comparatively simple. The surface of the paper has a naturally rough surface, and crayon pencils take very well. Never use lead pencils on a matte surface. They leave bright metallic marks which are more prominent from certain angles than the spot. Black crayon pencils, in varying degrees of hardness are best for spotting matte prints. Liquid spotting colors are also excellent for this type of corrective work.

d. Sepia prints on semi-matte and matte surfaces are spotted with crayon pencils or spotting colors in varying shades of brown. The spotting procedure is the same as for black and white prints. Toned prints in colors other than sepia may be spotted with appropriately colored crayon pencils.

2. Print toning. Photographic print toning is a process for changing the color of the black and white print image. The tone of normal black and white prints ranges from cold black (bluish) to warm black (brown or olive), depending on the emulsion, the developer composition, and the use of the developer. By chemical treatment, we can change the color of these black and white images.

a. Chemical toning. Generally speaking, chemical toning processes are divided into two classes, direct and indirect. A direct toning process is one in which the color is changed by treatment in a single solution that either dyes the image or converts it to a different compound. With an indirect toning process, the metallic silver image is first converted by a bleaching solution to silver ferrocyanide and then redeveloped in a second solution to obtain the desired tone or color. Although either chloride or bromide emulsions can be toned satisfactorily, chlorobromide emulsions are generally the best for chemical toning.

(1) Because blue tones produce an impression of coolness, they are frequently used for winter scenes, boating scenes, or scenes having a natural predominance of blue. A brown sepia toner is suitable for portraits, building interiors, autumn landscapes, some types of architectural subjects, or scenes having a natural predominance of brown. Excellent effects can be obtained by toning the prints to match, as nearly as possible, the predominant coloring of the original subject.

(2) Prints that are to be sepia-toned should be exposed and developed to produce a slightly greater overall density than is normally desired in a conventional black and white print. Their images are bleached, then redeveloped, but redevelopment is not as great as the first development and images appear lighter and less contrasty. On the other hand, because a blue toning process produces some intensification resulting in an increase in density, a print intended for blue toning should be a little less dense and softer in contrast than is normally desired in a black and white print.

b. A print intended for toning must be given an exposure such that the proper density of the image is obtained by full development as recommended by the manufacturer. It must be neither underdeveloped or overdeveloped. Unless development is correct, the tone of the final print will not be acceptable. For some toning processes, fixing and washing must also be complete, since a hypo-soluble compound is formed and the results can be affected by any hypo left in the print after washing.

CAUTION: Many chemicals used in the process of toning are harmful. Handle them with extreme care.

c. Operations using sodium sulfide or any other compound that gives off free hydrogen sulfide gas should be carried out in a well-ventilated room. This gas is toxic if inhaled in large quantities. As a detector against this danger, the "rotten-egg" odor of hydrogen sulfide is readily recognized. Although the odor cannot be completely avoided, if the room is adequately ventilated, the odor should not be unbearably offensive. Hydrogen sulfide has a detrimental effect on sensitized photographic materials. Toning operations should be carried out in a room away from stored sensitized materials.

d. Advantages of direct toning are that only one solution is required and quite often prints may be toned directly after leaving the fixing bath, with little or no intermediate washing. A principal advantage of indirect toning is that the final tone can be altered to a greater degree during the process and a greater variety of colors is obtainable. However, indirect toning is not recommended for Kodak RC paper.

e. There are toner formulas available to produce almost any desired color or tone. In addition to those already mentioned, copper toners are used to produce red tones; gold toners can be used to give a warm light brown or golden tone; and dye-bath toners are used for green, violet, yellow, and other colors.

f. Make sure that the type of paper used is recommended for toning and that it can be toned with the particular formula being used. A wrong combination can produce an off-color print that is anything but attractive. Formulas for many toners are given in various photographic technical books, formularies, and manufacturer's publications.

3. Mounting.

a. When preparing a print for display, the objective is to show the print to its best advantage. Simplicity is essential. Any elaborate artwork, such as colored borders or fancy lettering, will detract from the main point of interest, which of course, is the print.

b. Prints for display purposes are generally mounted on special cardstock to make them stand out from their surroundings. The cardstock is available in various sizes, colors, textures, and weights; and while no definite rules can be given, a mount should compliment the print. The mount should be large enough to balance and support the picture; the texture and color should contribute to the overall tone. For instance, a buff colored or cream colored pebble grained board would probably do more to enhance a sepia toned landscape than would any other color or texture of mounting board.

c. The placement of the print on the mounting board is of utmost importance. Prints mounted at odd angles or in a corner of the mount are not generally acceptable. The prints should be placed on the board in such a manner that the borders on the sides are equal to the top border. For good balance, the bottom border should be about one-third wider than the top and side. See method for optical centering (fig 2-14).

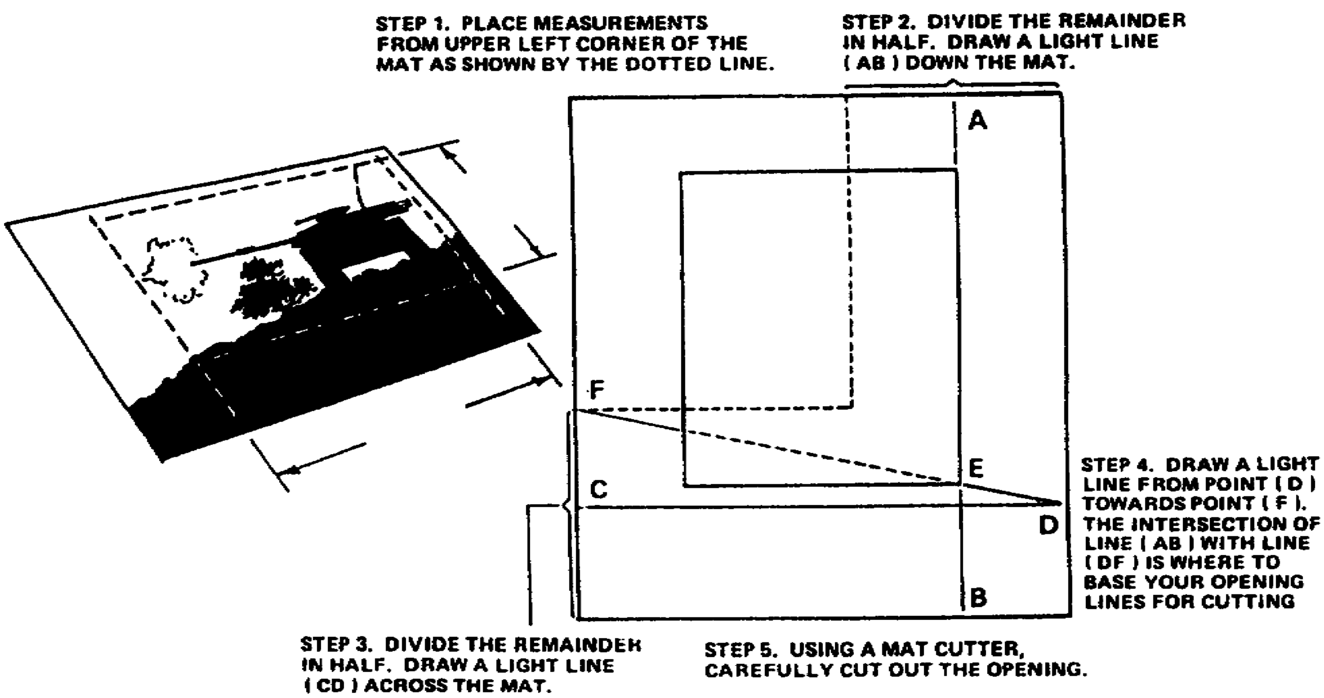


Figure 2-14. Method of optical centering

d. Adhesives. The adhesives used for mounting prints may be either wet or dry. The liquid adhesives generally used are photo paste, glue, gum arabic, or rubber cement. When you are using gum arabic, glue, or paste, it is almost impossible to prevent some staining or smearing of the mounting board around the edges of the print.

e. Rubber cement is the easiest and cleanest to use. Excess can be removed after it has dried by lightly rubbing it. There will be no damage to the print or mount if a good grade of cement is used. However, rubber cement is not permanent; and, in time, the print may loosen and peel off the mount. In this case, the print may be remounted with fresh cement. Rubber cement makes an ideal adhesive when prints are to be temporarily mounted for display purposes or for copying.

(1) When a permanent bond between the print and the mounting board is desired, you should use one of the dry mounting adhesives. One type of dry mounting employs pressure sensitive adhesive sheets that require no additional equipment or heat. To use this material, you simply peel off one side of the protective sheets and apply to the print. Then peel off the protective sheet on the other side of the material and mount the print in place.

(2) Another method of dry mounting prints is done by using dry mounting tissue, a tissue paper coated on both sides with a shellac type adhesive. The tissue is dry, thin, and not sticky, and very easy to handle. Furthermore, it is odorless and chemically inert so it will not stain a print. Being moisture proof, it will not wrinkle a print. It is well suited for either doubleweight or singleweight prints; and it gives a strong, flexible, and very permanent bond between prints and mount. The dry mounting process is so clean, simple, and efficient that it is by far the most widely used process when permanence and neatness are necessary.

(3) Although dry mounting presses are made for the express purpose of mounting prints with tissue, an ordinary electric hand iron will give good results if common sense is used to apply the principles of dry mounting with tissue.

4. Dry mounting procedure. When using dry mounting tissue, place the untrimmed print face down on the table. Fasten a sheet of mounting tissue as large as, or larger than the print to the back of the print by applying the point of a hot "tacking iron" (fig 2-15) very lightly at one point, in the center of the print. (The iron should be just hot enough to sizzle when touched with a wet finger.) Very little pressure is needed as the heat from the iron is usually enough to fasten the tissue. Then turn the print face up and trim both the print and the tissue to ensure they are exactly the same size and shape, with no overlapping edges. Then position the print on the mounting board and tack the tissue to the board by slipping the point of the hot iron between the print and the tissue, thus preventing the print from slipping after is has been properly positioned.

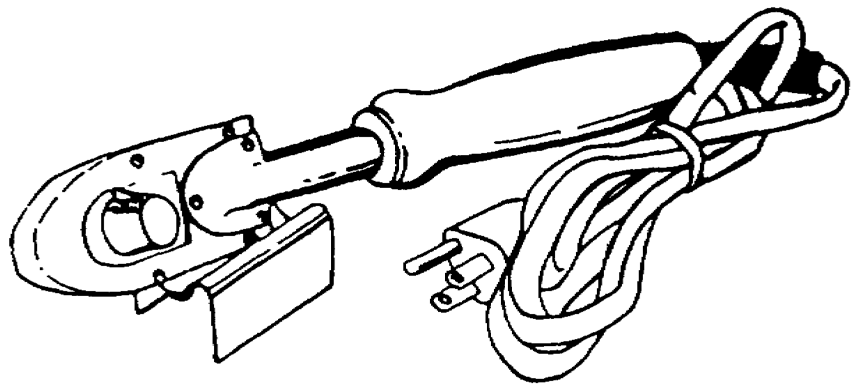


Figure 2-15. Tacking iron

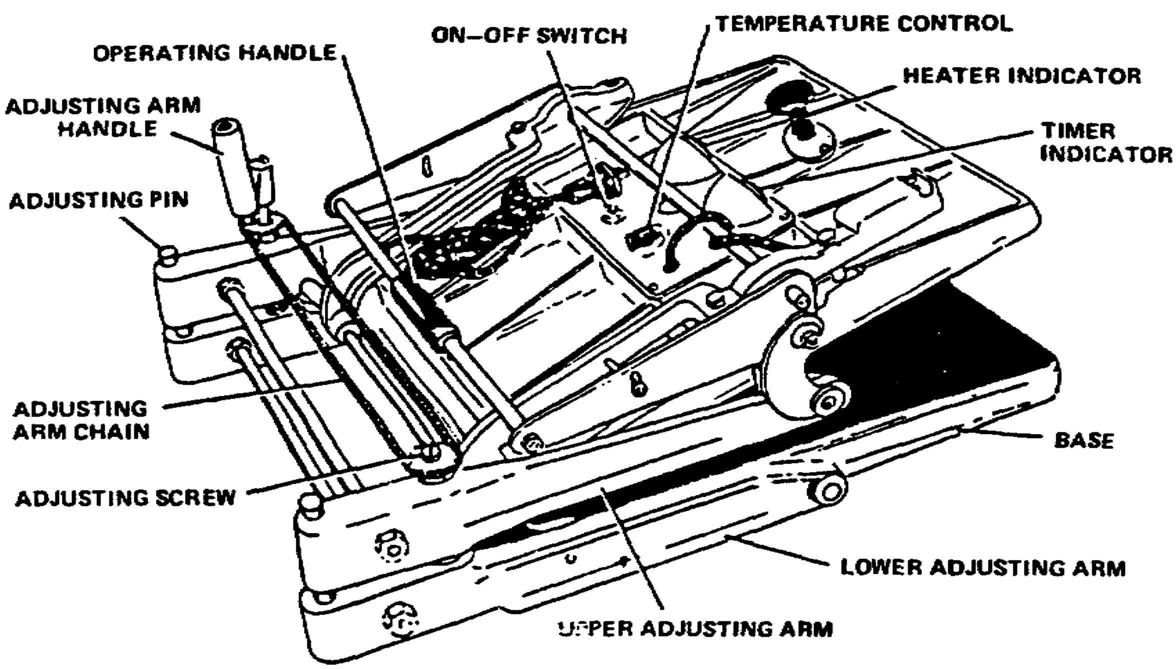


Figure 2-16. Dry mount press

a. Next, position the mount and print face up on a hard, even surface and cover them with a piece of clean protecting paper a little larger than the print. Apply heat with a firm pressure. If you are using a hand iron, it is best to start at the center of the print and work slowly toward the edges. Do not stop the movement of the iron or the print may be scorched or marked. Follow this procedure, always working from the center toward the edges, until the entire print is stuck down. As the shellac on the tissue is heated, it softens and penetrates into both the mounting board and the back of the print. After it has cooled, the bond between print and mount is permanent.

b. Some mounting tissues are designed to be used at lower temperatures than others. Either type of tissue can be used to good advantage, but the adhesive strength of the low temperature tissue is slightly less. Curled or heavy prints may come loose from the mount.

> NOTE: Excessive heat or prolonged exposure to heat will cause the adhesive to be absorbed by the print and mounting board. The adhesive must be retained at the surface of both the print and board. RC paper is particularly susceptible to a bubbling or complete removal of portions of the emulsion if too much heat is applied.

c. Prints are often mounted solely for the purpose of preserving or strengthening them. In such cases, the prints usually do not need a border, and weight is the principal consideration in choosing the mount. Prints are also mounted on a special type of adhesive, photo-mounting cloth. This is done by pressing the cloth against the wet back on the print during ferrotyping. The cloth backing is used on prints which must receive considerable handling and yet must be light and flexible.

d. When dry mounting prints, the temperature of the press should be accurately set and maintained according to the directions given with the tissue. Do not overheat the press, let it cool prior to beginning mounting.

e. During the actual mounting process, pressure, as well as heat, is required. A red light flashes "on" and "off" approximately once every second when the press is closed and provides a means for timing the process.

f. When placing the print and mount in the press, always hold the press open by the operating handle with one hand. Slide the print and mount into the press with the other hand. Even at its lowest range, the operating temperature of the press is hot enough to burn your hand seriously. Remember, the purpose of the press is to mount prints, not fingers.

Lesson 2
PRACTICE EXERCISE

1. When contacts are made as a final print, what is the minimum negative size?

a. 35 mm
b. 2- x 3-inches
c. 4- x 5-inches
d. 8- x 10-inches

2. What is the largest aerial roll film that the EN-22A can handle?

a. 4 inches wide and 5 inches long
b. 9 inches wide and 18 feet long
c. 18 inches wide and 500 inches long
d. 9.5 inches wide and 500 feet long

3. When judging print contrast what do you examine?

a. The highlights only
b. The shadows only
c. The middle tones only
d. Highlights, middle tones, and shadows

4. When projection printing a 35 mm negative, what focal length should the lens have?

a. 35 mm
b. 50 mm
c. 105 mm
d. 150 mm

5. What is the preferred printer to use when printing portraits?

a. Condenser printer
b. Diffusion printer
c. Parabolic printer
d. Projection printer

6. To aid in focusing the lens should be:

a. Closed down 2 stops
b. Closed down all the way
c. Wide open
d. Removed

7. When tilting the easel to correct for distortion during printing, in what condition must the lens aperture be?

   a. Wide open to correct for light loss
   b. Wide open to maintain depth of field
   c. Closed down to decrease light intensity
   d. Closed down to maintain depth of field

8. Generally, what is the emulsion best suited for chemical toning?

   a. Bromide
   b. Chloride
   c. Chlorobromide
   d. None of the above

9. When mounting prints for display, what is the primary objective?

   a. An essential aspect of the process
   b. To make the photographer look very good
   c. To mount the print on attractive cardstock
   d. To show the print to its best advantage

10. How should dry mounting tissue be fastened to the back of the print?

   a. By applying drops of glue at one or more points
   b. By applying a hot "tacking iron" at one or more points
   c. By gluing the borders securely to the print on all sides
   d. None of the above

You should now be familiar with the spotting, mounting, and toning of photographic prints. If there is any area you are not sure of, go over it again. If you feel competent of your knowledge of the material, go on to Lesson 3.

LESSON 3
PHOTOGRAPHIC QUALITY CONTROL

TASK

Perform quality control procedures in a photographic laboratory, including cleanliness, visual inspection, processing controls, replenishment, and chemical measurement (pH).

CONDITION

Given information and diagrams pertaining to cleanliness, visual inspection, processing controls, replenishment, and chemical measurement (pH).

STANDARD

Demonstrate competency of the task skills and knowledge by obtaining a minimum passing score of 80 percent on the multiple-choice test covering this subcourse.

REFERENCES

TM 11-401-1
TM 11-401-2

Learning Event 1:
NEED FOR QUALITY CONTROL

1. Quality control is as old as industry. From the time man began to manufacture, there has been an interest in output. As far back as the Middle Ages, guild members (now union members) were required to serve long apprenticeships. Only after long periods of training and demonstration of skills and techniques were they considered craftsmen. Even today, man strives to improve the quality of the end product and uses various controls. Standards have been set to assure quality; however, the standards that are set are only as good as those that are kept. Low standards equal low quality; high standards equal high quality. Inspections and tests are conducted to maintain and assure quality products.

a. Camera or laboratory technicians also are concerned about quality and aspects of its control. Quality control has one purpose; to assure repeatable quality of the end product, whether it is a negative, transparency, or some other product. Quality control can be applied to the entire system or any portion of it.

b. Detailed quality control, as applied to the photographic process, will assure you of a better product if defects are spotted as early as possible. Keeping your lab or working area as clean as possible is one of the simplest ways of assuring quality.

2. Cleanliness. In most publications regarding photography, you will find a section on defects. Close study will show that many defects are caused by a lack of cleanliness or sloppy habits in the laboratory.

a. Many photographic techniques concern the correction of errors or defects. Print spotting is one of these. Its purpose is to remove or hide white or gray spots which are the result of lint and dust. It's better to eliminate the cause rather than to use time correcting the defects. Let's follow a sheet of film, the negative, and its final product through the lab and see where these cleanliness pitfalls appear.

b. Your first pitfall can occur in the storage and cleanliness of equipment. The camera and accessories you use should be checked for dust, lint, and fingerprints on glass surfaces each time they are used. Through careless handling, the lens may be smudged with oily fingerprints. Fingerprints deteriorate photographic quality. In addition, since a fingerprinted lens is somewhat oily, it will catch and retain more dust particles than an unmarked lens.

c. Dust and lint create serious problems inside the camera. During operation, the dust and lint is distributed and deposited on the film. Removal of dust and lint prior to use is good preventive maintenance.

d. Static electricity causes dust to be attracted to various surfaces. Using an antistatic brush to dust the film holder prior to loading minimizes or eliminates the dust problem.

e. The area used for loading film should be free of dust. The use of a specific room for loading, other than the usual printing or processing area, will help to assure that no chemical dust gets on the film or camera. Before loading, the working area should be thoroughly cleaned.

(1) Extra caution is needed when you must use a processing room for film loading. Imagine a line drawn down the middle of the processing room to divide the dry side from the wet side. The dry side should always be dry. Inspect the dry area for wet or dry chemical deposits that could come in contact with the film. Clean any surface that might contaminate your film.

(2) Exposed film must be afforded the same treatment and consideration in unloading as in loading. This is one of the

most critical stages in film handling, because the unloading normally is accomplished in the same area where processing is done. Here again, check the dry side very carefully. When in doubt, wipe the area with a clean sponge or cloth and let dry.

f. Before processing, check the trays or tanks for cleanliness and chemical condition. Any chemical that has been unused for some time or appears dirty should be discarded and replaced with fresh solutions. False economy in this area could ruin your best negatives.

g. Drying your negatives introduces another critical step in the process. If you accidentally drop a wet negative, it must be rewashed to produce an acceptable product. However, if the negative is allowed to dry with dust or dirt particles on it, no amount of washing can remove the dirt. Therefore, you must check the drying area for cleanliness.

h. Another hazard is that of fingerprints caused by careless handling. Fingerprints should be removed from the surface of the negative as soon as they are discovered.

i. Keeping your processing area clean will save you additional work and materials. Your first consideration should be to maintain a dry side and a wet side, and keep the dry side dry!

j. After processing operations, your hands will be wet with water or chemical solutions. In either case, rinse them in clean water and wipe them on a clean towel, not one contaminated with chemicals. Be sure your hands are dry before you return to the dry side.

k. Chemicals splashed on the floor or your clothing may ruin prints when transferred to the dry side. Chemicals on the floor may go unnoticed until they dry to a powder. Walking back and forth agitates the powdery crystals and they become airborne. Ultimately, these particles settle on your negatives and paper, causing spots that require retouching on negatives and spotting on prints. Remember to clean up all spills immediately.

l. Regular cleaning of the laboratory is essential to quality production. No area should be overlooked. Floors should be swept with a dust mop rather than a broom. Then use a wet mop to rinse the floor with clean water. Never use a dirty mop, as this only moves the dirt from one place to another.

m. When a liquid is needed to complete a cleaning job, remember, plain water will remove most chemical deposits. If a solvent is necessary, use as little as possible while following all safety precautions connected with its use.

3. Visual quality assurance. While it is not a scientific procedure, visual quality assurance can greatly improve the quality of your product. As its name implies, visual quality assurance involves careful examination of your product, determining whether it satisfies the requirements of the work order, and determining its photographic quality. Generally speaking, you should look for such things as proper contrast, sufficient density, and the various mechanical and chemical defects. The best way to examine negatives is to place them on a standard viewing table. You may also use a contact printer, but if you do, the same number of lights should always be turned on. Another simple method for judging a negative is to hold it up to light being reflected from a piece of white paper.

> NOTE: When you examine a photographic image visually, make certain you are looking at it under normal viewing conditions. Use the same method each time you make a visual check of quality. Variations in viewing procedures can result in differing impressions of quality.

a. Negative density. The negative should have a full range of tones suitable to the original scene. If it has the proper density, it will have a wide range of tones all the way from shadows to the highlights.

b. Negative contrast. The difference between minimum and maximum densities is called contrast. A good negative will present these densities in about the same way that the brightness of the various parts of the subject appear in the scene. However, negative contrast is a reversed representation of the original scene contrast. An exact reversal is not always desirable. Sometimes you may want more or less contrast. By appropriate manipulation of the process, you can modify the tone rendition of the original.

c. Mechanical negative defects. These are the defects which cause the most concern. They may be caused by improper handling of the sensitized material, equipment malfunctions, poor techniques, or other things. In most cases, the cause for any of the following mechanical defects can be traced directly to the person making or processing the photographs. This list is by no means a complete one, but it does cover many of the more common errors.

(1) If the image appears hazy and lacking in contrast, it may be because:

(a) The sun was shining directly into the lens. Always protect your lens from direct rays of sun when shooting against the light.

(b) The lens is dirty.

(c) The negative is overexposed.

(d) The negative (film) is fogged.

(2) If you observe small transparent and irregularly shaped spots on a negative, they may be caused by dust inside the camera body settling on the film.

(3) Fingermarks are produced by touching the film with your finger.

(4) If you observe black streaks extending into the picture from one corner, or lying along the side of a negative:

(a) The streaks may be caused by light that is admitted through an opening in the back of the camera.

(b) The camera may have a light leak.

(c) The streaks may be caused by withdrawing the tab of a film pack incorrectly.

(d) The film holder may have a light leak.

(5) Small circular transparent spots, or air bells, are produced by air bubbles collecting on the surface of the film during development. These can be prevented by tapping the film or hanger after each agitation cycle.

(6) If the negative emulsion has a wrinkled or spider-web like appearance (reticulation), then the temperature of the solutions varies too much. Wide variations in temperature will cause an abrupt or sudden swelling and contraction of the film. Reticulation occurs when the film is transferred from one solution to another of higher or lower temperature, where the temperature difference is greater than 5 degrees Fahrenheit.

(7) Softening of the emulsion of the film edges is called frilling, and can be caused by:

(a) Warm developer,

(b) Old or incorrectly prepared fixer which doesn't harden the film satisfactorily, or,

(c) Prolonged washing, using warm water, or handling the film in extremely warm weather.

(8) If the image shows spots of different density, this may be caused by uneven drying.

(9) A streak of lesser density through the center of the film may be caused by curvature of the film in the solution, so that the center portion floats clear of developer during tray development.

(10) The image may be out of focus for any of the following reasons:

(a) The focusing is incorrect.

(b) The lens elements were not properly in place.

(c) The cut film holder, or pack adapter, was not in register with the focal plane.

(11) If part of your subject is cut off:

(a) The camera may have been moved before the exposure.

(b) The subject was not properly composed.

(c) The viewfinder is out of adjustment or you didn't correct for parallax.

(12) If image is not sharp, any of the following may be the cause:

(a) The subject moved.

(b) The camera moved.

(c) The subject was not properly focused.

d. Chemical negative defects. These defects usually occur during the processing of the film. They can, however, be caused anytime the film is allowed to come into contact with some chemical. Remember, cleanliness plays a large part in the elimination of chemical defects. The following is a partial list of some of the defects of this nature. Some chemical defects are caused by a combination of errors, both mechanical and chemical.

(1) If the image of your negative is partially positive, this is due to reversal of the image and is sometimes caused by hypo in the developer. More often, it is the result of a brief exposure to white light during development.

(2) Yellow stains appearing after the negative is dry are caused by insufficient fixation or the use of an old and exhausted fixing bath.

(3) Thin negatives result from underexposure or underdevelopment.

(4) Dense negatives result from overexposure or overdevelopment.

e. Mechanical and chemical print defects. These defects often occur for the same reasons that negative defects occur. In addition to underexposure, overexposure, and flat or contrasty prints, some of the more common print defects are:

(1) Yellow stain - caused by insufficient agitation in the fixing bath.

(2) Yellow-brown stain - caused by the use of an exhausted fixing bath.

(3) Yellow-orange stain - caused by underexposure and overdevelopment.

(4) Purple stain - results from lack of agitation or insufficient time in the stop bath.

Learning Event 2:
QUALITY CONTROL DURING PROCESSING

1. Gamma. Gamma is a numerical value representing the contrast produced in a negative through development. Changes in development (in time, temperature, and agitation) will vary contrast. An increase in development produces a higher gamma; a decrease in development produces a lower gamma. Materials capable of producing widely different gamma values are available. Normal photographic subjects call for film with a gamma value around 1.0, varying from 0.5 to 1.5. Such emulsion will record the wide range of tones which are present in outdoor scenes. In practice, each of the main groups of negative materials has its own individual characteristics. Gamma is useful to the photographer because it tells him how his photographic material will respond to corresponding changes in exposure and processing.

a. Controls in processing. The gamma value of photographic material is not fixed. It can be varied within wide limits by the choice of developer and the methods of development. The time of development is only one of the processing factors affecting gamma. Other factors are the type of developer used, dilution of the developer, processing temperature, and the method and cycle of agitation. If the gamma is measured and found to be high, an appreciable amount of development was obtained, even though the developing time may have been correct. Gamma is one of the most important tools used in processing control. Negatives developed to the same gamma, for example, show comparable tone reproduction. The highest gamma obtainable in any particular emulsions is called "gamma infinity". It depends on the emulsion and, to a lesser degree, on the composition of the developer used. Typical gamma infinity values for some different types of emulsion, when processed in the developers normally used for them, are as follows:

(1) High speed portrait film - 1.2

(2) High speed press film - 1.7

(3) Commercial film - 2.0

(4) Process film - 3.0

b. Time-temperature charts. Recall that one of the primary factors governing the density of an image is the temperature of the developer. The higher the temperature, the greater the activity of the solution, therefore, shorter developing times are needed. As the temperature drops, the developing time must be increased. Since gamma must also be considered, typical time temperature charts include a gamma value which varies according to development time and temperature. Designation of this value allows you to control development in order to produce a desired gamma. By consulting a time-gamma-temperature chart, which is published by the manufacturer of the film, you can determine the proper developing time under varying conditions. A typical chart of this type is shown in Figure 3-1.

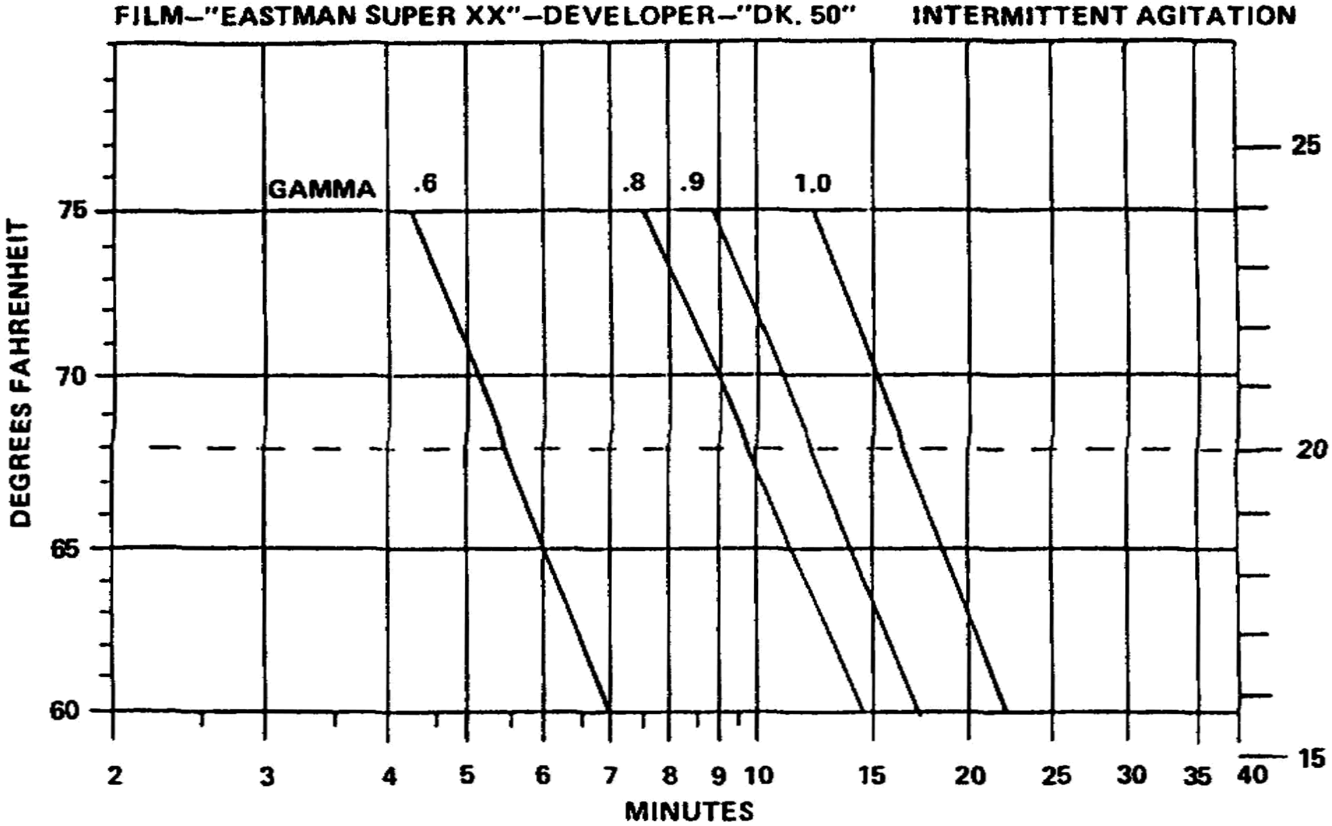


Figure 3-1. Time-temperature chart

2. Certification and replenishment. The equipment and methods presently used for compounding photographic solutions are the result of changes that have taken place over many years. These improvements have been made to keep up with the general demand for higher quality in the photographic product, and are made possible with modern designs in optics, cameras, processing equipment, and the ever increasing variety of sensitized materials.

a. The preparation of solutions can be compared to the fulcrum of a balance. On one side, we have the optics and mechanics of exposure; on the other side, we have the chemical and mechanical conditions of processing. Conditions of exposure demand equal care and control in processing. You must balance one against the other for optimum results. Substandard solutions make it virtually impossible to carry on a processing operation within controlled limits. Any degree of uniformity obtained from an uncontrolled operation is purely accidental and cannot be considered reliable.

b. The highest quality standards can be achieved only when the conditions of exposure, chemistry, and processing are normal or within operating tolerances. The net desired situation, with its complete dependence on the above, is a predictable result. When effective quality control procedures are being practiced, chemical analysis is often used to check all chemistry solutions before and after use. To keep chemistry up to prescribed standards and to locate or isolate causes of imperfect processing results caused by faulty or defective chemistry, good quality control procedures are essential. Furthermore, these procedures permit the determination of proper replenishment formulas and rates to promote economy in the consumption of chemicals. Quality control at this point guarantees that solutions are properly prepared, used, and discarded.

3. Evidence of developer exhaustion. The function of a developer is to effect a chemical change in the sensitized materials passed through it. It is apparent that the condition of the developing solution itself must change with use.

a. Since developer is often used more than once, in particular when tank development is employed, it is important to know what changes to expect, how these changes affect the function of the solution, and what can be done to prevent them or to compensate for them. The major factors which affect the performance of the developer are as follows:

(1) Loss of volume through evaporation and carryout.

(2) Loss of activity of components due to chemical reaction (development and aerial oxidation).

(3) Loss of development potential because of an increase of bromide content.

(4) Changes in physical content due to foreign matter, dirt, gelatin, etc. entering the solution.

b. A good replenishment program attempts to replace used up or carried out components and to dilute those which have increased. It tries to maintain the activity of the developer to approximate that of a fresh solution or at some point after the peak of freshness has been removed. Some technicians "ripen" solutions before starting their replenishment program. To ripen a solution, process several sheets of fogged photographic material in the developer solution to reduce the developer from a completely fresh state to a partially used state where it is more stable.

c. Principles of replenishment. It is possible for a developing solution to become exhausted to the point that processing for a normal length of time will produce no density except possibly in the most heavily exposed areas. Such a developer would be totally exhausted and of no more use. Exhaustion can be defined as being a point below which results are of unacceptable quality.

d. As a developer solution becomes exhausted, we must analyze what happens to each component of the developer. In a previous lesson, you learned the parts of a developer and their function. You recall:

(1) Solvent or water is used to dissolve the chemicals.

(2) Reducing agents are used to change the exposed silver halides to black metallic silver.

(3) Preservatives are used to prolong the life of the reducing agent.

(4) Accelerators speed up the action of the reducing agent.

(5) Restrainers slow the action of the reducing agent.

(6) Special additive ingredients are used when processing at higher than normal temperatures, to minimize aerial fog, and to act as a wetting agent.

(a) When a developer has been in continuous use for a period of time and has reached the point of exhaustion, the most noticeable change is that it has lost efficiency. First, the quantity of the solution is less, due partly to evaporation, but chiefly to carryout. Second, the accelerator or alkali, developing agent (reducing agent), and preservative are reduced in strength and volume. Also the exhausted solution contains an increased amount of bromide, waste products such as gelatin, sensitizing dyes, antihalation dyes, free silver, etc. Still another thing to consider is the presence of foreign matter, dust, dirt, etc., which could be removed by filtration.

(b) The increased formation of bromide in an exhausted developer solution is of great concern. The emulsion coating on sensitized film material contains bromide which is released into the developer during processing. This action eventually results in excessive bromide concentration, called bromide buildup, which increases restraining action. Since the excess bromide slows down the action of the developer at an ever increasing rate, the first consideration in designing a developer replenisher is to control the bromide buildup. Your attention must be turned to replacing these consumed components, i.e., the accelerator, developing agents, and the preservative.

e. Procedures for replenishment. With varying degrees of success, depending upon the nature of the developer, the decrease in developer activity with use can be partially overcome by increasing the development time. This procedure is available with instructions from the various developer data sheets.

(1) A better procedure and one particularly valuable when large quantities of solution are involved, is to compensate for the developer exhaustion by periodically adding small amounts of replenisher solution. Usually replenishers are such that, when used as recommended, the developer activity is held approximately constant.

(2) The quantity of the developer solution carried out varies with the processing conditions. Most replenisher formulas are balanced to suit their major field use. For other conditions, adjustments may be necessary. If, after replenisher has been added, the developer is still at a low activity level, more replenisher should be added, even though it is necessary to discard some developer. However, if the developer tends to gain in strength, when the replenisher added is just sufficient to replace that carried out, dilute three or four parts of replenisher to one part of water and add to the solution to keep the volume constant.

(3) Small volumes of developer, such as are used in hand-processing, are best replenished by the addition of a definite quantity of replenisher for each roll or sheet of film processed. Ordinarily, constant developer activity can be maintained by adding one ounce of replenisher for each 80 square inches of film. This is equivalent to one 8x10 or four 4x5 sheet film, one 120 roll film, or one 36-exposure roll of 35 mm film. After processing one roll of film (80 sq. in.), pour one ounce of replenisher solution into the developer storage bottle. Add enough of the used developer solution to bring the bottle to original volume. If original volume is not attained, add unused developer solution or replenisher diluted two parts with one part water to make up for the loss. Repeat for each roll (80 sq. in.) developed.

(4) This is only one of the many ways that a developer can be replenished. It is impractical to replenish a developer indefinitely, because the solution accumulates a silver sludge as well as particles of dirt and gelatin which may adhere to the film surface. The developed film should be examined carefully. If they show any indication of stain or fog, the developer should be discarded.

(5) One of the best ways to monitor the activity of a developer is to develop periodically a series of sensitometric strips as the solutions are used. A sensitometric strip is a

piece of photographic material with a series of exposures on it used to evaluate the developer solution. (The evaluation and control of the developer solution is only one of the many uses of the sensitometric strip. The sensitometric strip is a very significant part of sensitometry; the science of determining the photographic characteristics of light sensitive materials.)

(6) If the composition of the developer is kept constant, the information derived from the sensitometric strip will tell you graphically that the contrast of the material you are processing is staying constant. If replenishment is too great, or too little, a sensitometric strip will indicate that the contrast (gamma) has increased or decreased.

4. Measurement of pH. In the laboratory, pH measurement is a matter of great importance. There are hundreds of acids and alkalis (bases) of varying strength (fig 3-2).

SOLUTION	pH
Gastric fluid	1.6
Vinegar (4% acetic acid)	3.1
Orange juice	3.8
Milk	6.9
"Pure" water	7.0
Borax (9.0%)	9.3
Ammonia (10%)	11.8

Figure 3-2. pH values of common substances

Practically, pH can be viewed as a measurement of the acidity, alkalinity, or neutrality of a solution. The pH scale is shown in Figure 3-3.

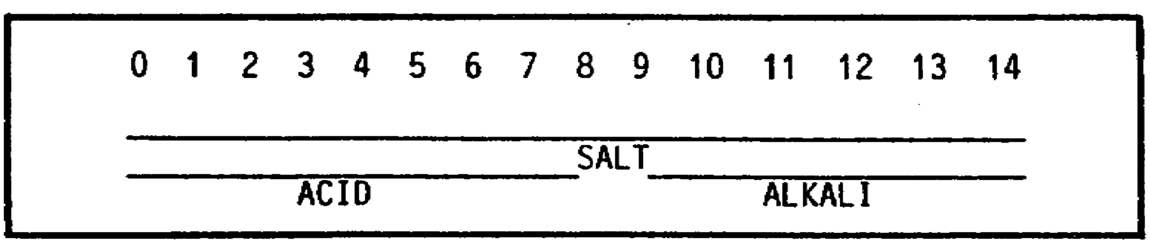


Figure 3-3. pH values

a. pH values. The pH scale extends from 0 to 14, with 7 representing the pH of pure water at 25 degrees Celsius, or any perfectly neutral solution. On the pH scale, numbers greater than 7 indicate the degree of alkalinity. As you proceed up the scale to 14, a pH of 8 represents a slightly alkaline solution and a pH of 14 represents the strongest alkaline solution. Moving down the scale from 7 to 0, indicates the degree of acidity. A pH of 6 indicates a slight acid solution and a pH of 0 indicates the strongest acid.

(1) The relative strength of acids and alkalis changes ten times for each unit change in pH. Compared with a solution of pH 6, a solution of pH 5 is ten times stronger, a solution of pH 4 is a hundred times stronger, and a solution of pH 3 is a thousand times stronger than a pH 6. This is also true of the alkaline scale 7 to 14.

(2) Acids and alkalis are considered to be strong chemicals and therefore must be handled very carefully. Acids and alkalis are quite capable of causing serious skin damage. When preparing solutions containing these chemicals (compounds), always follow the CAUTION and WARNINGS listed on the containers.

(3) Generally, a developing solution must be alkaline in order to reduce silver halides efficiently. Refer to Figure 3-4.

pH VALUES OF VARIOUS DEVELOPERS	
Caustic Process Developer	10.5 - 11.0
M.Q. Carbonate (paper dev.)	10.0 - 10.3
M.Q. Borax (Fine grain neg. dev.)	9.2
Metol (Diamine Ultra fine grain)	6.9 - 9.0
Amidol print developer	6.9 - 9.0

Figure 3-4. pH values of various developers

b. All pH measurements must be obtained relative to a standard reference solution. This means that every accurate pH measurement actually requires two measurements; one for the

standard referenced solution (commonly called a buffer) to standardize the pH meter and the other to obtain the pH value of the test sample, relative to the standard.

(1) Buffer solution. A buffer solution is used to standardize the pH meter to a known value. Normally, three different pH solutions, having values of 4, 7, and 9 are used for this purpose. The exact pH value of a buffer is listed on its label. If a buffer is used at temperatures other than those recommended by the manufacturer, a temperature compensation table should be consulted. To assure accuracy, always select a buffer which most closely approximates the pH value of the solution being tested. For example, when testing a developer solution, use a buffer with a pH value of 9, while for a fixing bath use a buffer with a pH value of 4. When testing a solution with an unknown value, use a buffer with a value of 7 (neutral).

(2) Litmus paper. Litmus paper is used to determine the acidity or alkalinity of an unknown solution. If the solution contains acid, the litmus paper turns red. Blue litmus paper indicates that a solution is alkaline. Certain types of litmus paper respond in various shades of red or blue, depending on the amount of acid or alkali contained in the solution. This paper is matched to a reference scale to determine the actual pH value of the solution. Once this test has been completed and the identity of the solution known, an appropriate buffer is used to standardize the pH meter.

5. The pH meter. Measurement of pH by a meter is accomplished by determining the potential developed by an electrical cell. This cell consists of two electrodes, a glass electrode and a reference electrode, immersed in a test solution.

a. The purpose of the reference electrode is to provide a constant reference voltage to permit measurement of the potential of the glass electrode. The reference electrode is filled with a saturated solution of potassium chloride (KC1). The constant voltage is supplied by this KC1. A small, but constant flow of KC1 solution is maintained through a liquid junction in the tip of the reference electrode. The KC1 solution forms a conductive salt bridge to the sample solution, between the two electrodes.

b. The basic purpose of the glass electrode is to measure the hydrogen ion concentration of the sample. The electrical potential developed at the glass electrode is proportional to the pH of the solution. The measurement of the electrical potential, developed at the glass electrode, is accomplished with the pH meter. The potential may be read directly either in pH units or millivolts.

c. Some pH meters are equipped with a combination electrode which incorporates both a pH-sensing element (glass measuring electrode) and a reference electrode in one assembly. This electrode also has a plastic coating to protect the sensitive glass tip.

d. The chemical mixture in the reservoir is a potassium chloride solution saturated with silver chloride. The level of solution should be kept directly beneath the filling hole which should be uncovered when not being used.

e. The electrode should be stored in tap water or pH 4.01 buffer. Do not store it in basic (alkaline) solutions, because they tend to etch the glass.

f. For other types of electromechanical potential measurement, such as oxidation reduction, a metallic electrode is substituted for the glass electrode and the readout is in millivolts. Do not use metal electrodes for testing developers.

g. The actual use of a pH meter is up to the brand name available to you. There will be detailed instructions for each type of meter, and how to use it (furnished with the equipment).

Lesson 3
PRACTICE EXERCISE

1. What is one of the simplest ways to maintain a high quality control standard?

   a. Carefully observe your peers while they are working
   b. Maintain a current working knowledge of your environment
   c. Make a list of everything that can go wrong and make sure it doesn't
   d. Keep your lab or working area as clean as possible

2. In many cases, what can the cause of mechanical defects be traced to?

   a. Weak or exhausted developer solutions
   b. Saboteurs who are trying to make you look bad
   c. The person making or processing the photographs
   d. So many things that it isn't worth worrying about

3. What are thin negatives an example of?

   a. Mechanical defect
   b. Chemical defect
   c. Broken lens element
   d. Poor photograph

4. What does using an old or exhausted fixing bath cause?

   a. Yellow stains
   b. Yellow-brown stains
   c. Yellow-orange stains
   d. Purple stains

5. What is the highest gamma value obtainable in any particular film?

   a. High contrast
   b. High gamma
   c. Maximum gamma
   d. Gamma infinity

6. What is one indication of bromide buildup in the developer?

   a. The presence of stains on the print
   b. A distinct odor emanating from the solution
   c. A slower rate of development of the image in the print
   d. The separation of the film emulsion from the base

7. What does pH measure?

   a. Alkalinity
   b. Acidity
   c. Neutrality
   d. All of the above

You should now have an understanding of quality control and its make-up. If there are any areas you are not sure of, go over them now. If you feel ready, read the summary for a quick review.

SUMMARY

Congratulations! You have completed this subcourse. You should now be familiar with photographic lab operations.

In brief, we have covered preparing different chemicals and how they are used; processing film at different time and temperatures by the tray and tank method; identifying and processing photo paper; contact printing with printing frame and contact printer; projection printing and the different means to improve the print; how to spot, tone, and mount prints; and methods and reasons for quality control.

The subject covered will help you produce excellent quality photographic prints.

This subcourse is not designed to make you an expert in the lab, but to help you gain the knowledge required to perform there. It will take many hours of actual experience before you will be a pro.

Now, it's time to take the examination. When you have finished the exam, mail it back in the envelope provided. Remember, to keep your book for use as reference material.

ANSWERS TO PRACTICE EXERCISES

Test Question Number	Correct Response	(Learning Event	Reference Paragraph	Page)
		Lesson 1		
1	c	1	4a	3
2	d	1	2	2
3	c	1	5a	5
4	c	1	1a	1
5	a	2	3b	11
6	c	2	3a(3)	10
7	c	2	5a	12
8	c	2	6a	14
9	a	2	6a(3)	14
10	b	2	7c	16
11	c	2	8	16
12	d	2	12d	23
13	a	3	2c	26
14	c	3	3	26
15	d	3	4	26
16	b	3	4b(1)	27
17	a	4	2b(1)	33
18	d	5	1	35
19	a	4	1c(1)	32
20	d	4	2d	34
		Lesson 2		
1	c	1	1a(1)	48
2	d	1	2d	49
3	b	1	3a(7)	51
4	b	2	2b(4)	59
5	b	2	2c(2)	59
6	c	2	3c	61
7	d	2	6c	69
8	c	3	2a	72
9	d	3	3a	73
10	b	3	4	75

ANSWERS TO PRACTICE EXERCISES (Cont)

Test Question	Correct Response	(Learning Event	Reference Paragraph	Page)
		Lesson 3		
1	d	1	1b	81
2	c	1	3c	83
3	b	1	3d	85
4	b	1	3e(2)	86
5	d	2	1	86
6	c	2	3c(2)	90
7	d	2	4	92