

Using KODAK Kit Chemicals in Motion Picture Film Laboratories

This publication is written especially for laboratory operators. It provides the most commonly used technical information about film processes for using KODAK ECN-2 Kit Chemicals and KODAK ECP-2E Kit Chemicals in your motion picture laboratory. Using KODAK Kit Chemicals will help you provide optimum results with the least environmental impact possible. This publication describes the processing cycles recommended for processing KODAK Motion Picture Negative Films and KODAK Motion Picture Print Films.

This manual is divided into five sections:

- Chemicals and Chemical Handling
- KODAK ECN-2 Kit Chemicals
- KODAK ECP-2E Kit Chemicals
- Process Monitoring and Troubleshooting
- Appendix/Index

For more detailed information on processing, see KODAK Publication No. H-24, *Processing KODAK Motion Picture Films*, or the Entertainment Imaging Internet site www.kodak.com/go/motion.

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CHEMICALS AND CHEMICAL HANDLING

High-quality customer orders begin with proper chemical handling and your choice of chemicals. Chemical handling includes how you store and mix chemicals and your attention to chemical safety.

This section includes:

- Chemical terms
- How each solution affects your results
- Choosing the right chemicals for your process
- Features and benefits of KODAK Kit Chemicals for Processes ECN-2 and ECP-2E
- Safe handling of photographic chemicals
- Chemical mixing
- How to check chemicals
- Solution storage
- Compensating for evaporation
- Cleaning tanks and racks
- Disposing of processing effluent
- Regeneration
- Silver recovery

Chemical Terms

Chemical Terms

To help you understand the terms we've used to describe the chemicals in this manual, here are some definitions:

Chemical Concentrates or Concentrates—Chemicals that must be diluted to make replenisher or tank solutions.

Fresh Solution—Newly mixed, unseasoned solution.

Replenisher—Solution used to restore the chemical components of the tank solution to maintain photographic performance over time.

Regenerator—Solution or concentrate added to tank-solution overflow to convert it for reuse as replenisher solution.

Seasoned Solution—A tank solution that has been used and replenished for a period of time. The chemical components and seasoning by-products of a seasoned solution are at an optimum **equilibrium** level for processing.

Starter—Concentrate added to a replenisher to prepare a fresh tank solution so it yields results similar to those provided by a seasoned tank solution.

Tank Solution—The solution used in the processor tank; often referred to as “working solution.”

How Each Processing Solution Affects Your Results

Each solution affects the emulsion differently. Understanding the reaction of each solution can help you diagnose processing problems.

Developer—The developer chemically reduces the exposed silver halide in the film to form a metallic silver image. At the same time, the color developing agent in the developer oxidizes and combines with the dye couplers at the site of the silver image in each of the dye-forming emulsion layers to form a color image. Once the dye image has formed, there is no need for the silver image. It is removed by bleaching and fixing.

The amount of cyan, magenta, and yellow dye formed depends on exposure and developer activity. Temperature, time, pH, chemical constituent concentration, replenishment rate, replenisher concentration, agitation, and the rate at which solutions diffuse into the emulsion affect developer activity. Time, temperature, and agitation affect the diffusion rate. With *too much* developer activity, too much dye forms; with *too little* activity, not enough dye forms.

Stop Bath—This is an acidic solution that stops the development of silver halide grains, and washes Color Developing Agent from the film.

Bleach—In the film process, the bleach converts metallic silver into silver halide. The silver halide is dissolved in the fixer. Bleach concentration and the rate at which the solution diffuses into the emulsion affect bleach activity. Time, agitation, and temperature affect the rate of diffusion. Replenishment rate, mixing procedures, and aeration efficiency affect the chemical concentrations.

If bleaching is inadequate, less than the normal amount of cyan image dye is formed because some of the dye remains in the leuco (colorless) condition. This affects the color balance. Bleach time that is too short or bleach that is too dilute can cause leuco-cyan dye to form. Low pH can also cause leuco-cyan dye.

Inadequate bleaching can cause retained silver because not all of the metallic silver is converted to silver halide. Leuco-cyan dye and retained silver adversely affect image quality, but you can correct both conditions by re-bleaching and re-fixing the film in good solutions.

Processing Solution Effects

Fixer—In a film process, the fixer converts silver halide in the film into soluble silver complexes. Most of these silver complexes remain in the fixer solution; you can recover the silver with electrolytic silver-recovery units and/or chemical-recovery cartridges. Fixing efficiency depends on fixer activity and the diffusion rate into the emulsion. Temperature, replenisher concentration, and replenishment rate affect fixer activity. Time, temperature, and agitation affect the diffusion rate.

Inadequate fixing may not remove all of the sensitizing dyes and silver halide. An increase in the red and green D-min densities of the control plot is one sign of incomplete fixing. Another sign is a milky appearance in the D-min areas of control strips and processed film. If this problem occurs, you can test the fixer by re-fixing the control strip (or film) in a fixer that you are sure is good. If re-fixing the strip corrects the control plot, the original fixer is probably exhausted. You can correct inadequately fixed film by re-fixing it.

The most probable causes of inadequate fixing are fixer that is diluted by excessive solution carryover, an inadequate fixing time, under-replenishment (or replenisher that is under-concentrated), and fixer sulfurization.

Agitation is necessary primarily for uniform fixing.

Final Rinse—The final rinse step promotes uniform drying, and reduces water spotting. Wash water removes residual chemicals from the film. Good washing requires enough circulation to keep fresh water in contact with the emulsion. The water temperature must be warm enough to swell the gelatin so the water moves freely into the emulsion to remove the chemicals, but not so warm that it damages the emulsion. A thorough final wash is necessary because chemicals that remain in the film (particularly fixer) can cause dyes to fade.

Choosing the Right Chemicals

Choosing the Right Chemicals for Your Process

Kodak is committed to providing labs with chemicals that are safe and easy to use. The kit chemicals designed for motion picture labs are supplied in liquid concentrates for easy mixing and handling; they are available in convenient and economical sizes.

Features and Benefits for Kit Chemical Processes

Features	Advantages	Benefits
Complete Packaged Kit	<ul style="list-style-type: none"> • Easy to use • No technical lab staff needed • Avoids mixing errors • Saves time – no measuring out of chemicals • Saves effort – just add water 	<ul style="list-style-type: none"> • Potential labor savings due to reduced chemical analysis, reduced measuring and re-mixing due to errors • Better productivity
Kodak branded	<ul style="list-style-type: none"> • Consistent chemical strength of solution • Mixes to correct aims • Meets current environmental standards • Consistency from mix to mix 	<ul style="list-style-type: none"> • Higher quality process produces higher quality results • Little chemical analysis needed for standard production • More satisfied customers
All-liquid	<ul style="list-style-type: none"> • Fewer chemical powders being used 	<ul style="list-style-type: none"> • Less dust for chemical mixers
Supplied by Kodak	<ul style="list-style-type: none"> • Only need to order from one supplier 	<ul style="list-style-type: none"> • Reduced ordering/admin. costs
Stocked by Kodak	<ul style="list-style-type: none"> • Order as needed, not in bulk 	<ul style="list-style-type: none"> • Reduced inventory carrying costs
Supported by Kodak	<ul style="list-style-type: none"> • Full Kodak technical support for problem resolution 	<ul style="list-style-type: none"> • Reduced lab down-time • Easy to get help
Regeneration	<ul style="list-style-type: none"> • Uses less chemicals 	<ul style="list-style-type: none"> • Reduced costs • Reduced effluent

Chemical Handling

Safe Handling of Photographic Chemicals

Handle all chemicals carefully. For more information about potential health hazards and safe handling of specific Kodak chemicals, see the label and the Material Safety Data Sheet (MSDS) for the chemical or call the Kodak health, safety, and environmental information hotline at (585) 722-5151, 24 hours a day, 365 days a year. In countries outside the U.S. and Canada you can also contact Kodak in your country.

Follow Instructions Carefully—Kodak chemical packages have precautionary information on the labels. Always follow the label instructions. Read the Material Safety Data Sheets (MSDS's) for more handling information. Material Safety Data Sheets are available at the Entertainment Imaging website, www.kodak.com/go/motion. If you need additional help in the U.S. and Canada, call the Kodak Information Center at (800) 242-2424, extension 25, or ask your Kodak sales representative. Please supply the catalog (CAT) numbers for the chemicals when you request MSDS's. In other regions, contact Kodak in your country.

Store Chemicals and Processing Solutions Safely—Keep chemicals and processing solutions out of the reach of children and pets. **Do not** store chemicals where you handle or store food. **Do not** eat, drink, or smoke in chemical-handling areas. Always wash your hands thoroughly after handling chemicals, especially before eating or drinking.

Label All Chemicals Properly—In the U.S., The Occupational Safety and Health Administration (OSHA) Hazard Communication Standard requires employers to inform employees about hazardous chemicals in the workplace. This standard requires that all containers of hazardous chemicals, including storage and processor tanks, be labeled. These labels must give the chemical hazard, handling instructions, and the action to take in case of accidental contact. Other countries may have similar requirements, so check with local authorities or Kodak in your country. Label information may be found on the Entertainment Imaging website at www.kodak.com/go/motion.

Chemical Handling

Keep the Mixing Area Clean—Clean up spilled chemicals as soon as possible with mild soap and water; wear nitrile rubber gloves. Residue from dried chemicals can become airborne and be inhaled or contaminate processing and printing areas.

Wear Protective Clothing—Wear goggles or a face shield and an apron (made of PVC) and protective gloves (made of nitrile rubber) when you mix solutions. Clean protective clothing after use to remove any chemical residue that can cause contamination.

Handle Chemicals Carefully—Avoid contact of any chemicals with your skin; some photographic solutions, particularly developers, can cause skin irritation and an allergic skin reaction. In case of accidental chemical contact, wash your skin with running tap water and a non-alkaline (slightly acid) hand cleaner. If symptoms persists, get medical attention. There must be an eyewash station handy to all employees. The station must be capable of providing a 15-minute flush of water or eye-wash fluid at a rate of 1.5 litres/minute. All employees must know the location of the eyewash station, as well as the location of fire extinguishers and first-aid kits.

Ventilate the Area Properly—Some photographic chemicals and solutions give off vapors and gases. For safety and comfort, keep the concentration of these vapors and gases to a minimum. To minimize the concentration of vapors and gases, provide good ventilation (about 10 changes of room air per hour) and use covers and floating lids on all solution storage tanks (which also helps reduce evaporation and oxidation). Also, keep the processing tanks enclosed and vent the dryer according to the manufacturer's specifications.

Chemical Mixing

Chemical Mixing

For the most current information, follow the mixing instructions packaged with the chemicals or on the label of the chemical container. Follow all safety precautions and handling recommendations given in the instructions.

Contamination Can Ruin a Process—To minimize the possibility of contamination, keep processing and mixing equipment and storage containers clean. Dirt and contamination can affect the life and photographic quality of the processing solutions. Avoid conditions where solutions can come in contact with other chemicals. Developers are especially sensitive to contamination. Small amounts of fixer or bleach solution can contaminate developer solutions and cause adverse photographic effects. To lessen the possibility of contamination, thoroughly rinse and clean processing and mixing equipment and storage containers before use. Be careful not to drip solution into other tanks when you remove racks for cleaning. Wash and rinse processing and mixing equipment thoroughly before reusing it. Contamination is most often caused by—

- solution splashed or dripped into another solution
- using mixing equipment that has not been thoroughly cleaned
- dry chemicals that become airborne during mixing
- pipes and tanks made of material that reacts with the photographic chemicals

How to Check Your Chemicals

Fresh KODAK ECN-2 Kit Chemicals and KODAK ECP-2E Kit Chemicals concentrates and solutions have a characteristic appearance and odor. By checking the appearance and odor, you may be able to determine if a concentrate was stored properly or if a solution was mixed correctly.

Solution Storage

Solution Storage

- Store *chemical concentrates* at 5 to 30°C (40 to 86°F) in a dry location. At temperatures lower than 5°C (40°F), components may come out of solution or crystallize. Temperatures higher than 30°C (86°F) will accelerate chemical reactions and cause deterioration.
- Store *mixed solutions* in polyethylene storage tanks at approximately 21°C (70°F).
- Storing a replenisher at too high a temperature accelerates oxidation and evaporation. Storing a replenisher at too low a temperature can affect the temperature of the tank solution.
- To reduce oxidation and evaporation, use floating lids on all solutions.

For best results, *do not* use KODAK ECN-2 Kit Chemicals and KODAK ECP-2E Kit Chemicals stored longer than the times given in the table below.

Mixed Solutions	Solution in Processor— No Operation	Replenisher in Covered Tank with Floating Lid
Developer	1 week	2 weeks
Prebath	1 week	2 weeks
All others	4 weeks	8 weeks

Compensating for Evaporation

Compensating for Evaporation

When water evaporates from processing solutions, the chemical components remain and the solutions become overconcentrated. Evaporation occurs naturally to some degree, but it is more likely to occur when tank solutions are up to temperature, but no film is being processed or when solutions are cooling down after shutdown. “Down-time evaporation” occurs after you shut down your processor; the level of your processing solutions is lower in the morning when you start up your process. When the process is running, there is also a slight loss of solution volume due to evaporation. With typical utilization, most replenishers deliver enough water to compensate for evaporation that may occur when the processor is running. However, if your processor operates at low utilization, evaporation may take place at a greater rate than what was built into the design of the replenisher solutions. You can compensate for “run-time evaporation” by topping off your solutions with water at a temperature that is close to the temperature of your tank solutions. *Never use cold water to top-off solutions.*

It is difficult to accurately estimate the amount of run-time evaporation that may occur, because some labs do not have the capability of monitoring the specific gravity of processing solutions, and because there are many variables that contribute to the severity of the evaporation.

Compensating for Evaporation

1. *At daily start-up*—With the recirculation system on, check the level of the tank solutions. If the tank solution level is not up to the top of the overflow tube, add water—at approximately operating temperature—to bring the solution level up to the top of the overflow tube.

If the solution level is at the top of the overflow tube, squirt the top edges of the tank and the rollers at the top of the rack lightly with warm water to remove any buildup of dried chemicals. Do not use too much water to avoid severely diluting the tank solution.

2. *During production*—Check the level of the processing solutions at least once during the day or shift. *Check the solutions when you are not processing film.* If the level of the tank solutions is lower than the top of the tank overflow tube, determine the reason for the loss. If the loss is slight, it may be due to evaporation. To alleviate this condition, run film or add a very slight amount of water to bring the tank to the appropriate level.

If the solution level is at the top of the overflow tube, squirt the top edges of the tank and the rollers at the top of the rack lightly with warm water to remove any buildup of dried chemicals. Do not use too much water to avoid severely diluting the tank solution.

When using this technique, it is important not to disturb solids, which can drop back into the solution as solid particles. This would be a source of dirt. This technique will only work if there is minor evaporation and you are redissolving some chemical salts back into solution.

3. *At shutdown*—Squirt the top edges of the tank, the top of the rack, and the rollers at the top of the rack lightly with warm water to prevent the buildup of dried chemicals. Do not use too much water to avoid severely diluting the tank solution. To minimize chemical buildup, Clean and rinse crossovers thoroughly using only small amounts of water.

Cleaning Tanks and Racks

Cleaning Lab Tanks and Racks

Biological growth can occur in final rinse and wash tanks, and is a potential source of dirt. Clean wash tanks weekly, and final rinse tanks as needed. KODAK ECN-2/ECP-2E Kit Final Rinse and Replenisher contains PROXEL GXL to help control biological growth. Wear protective gloves and splash-proof goggles when you follow this procedure.

To remove biological growth:

1. Empty the processing solution or wash water tank. Dispose of waste solutions according to local or state disposal regulations.
2. Rinse the tanks and racks with hot water; drain the rinse water and repeat.
DANGER! The addition of cleaning agents that contain strong acids or oxidizing agents (e.g., chlorine-containing bleaches) to some photoprocessing solutions may release irritating and toxic gases, such as sulfur dioxide. **Do not** add cleaning agents to processing tanks unless the tanks and racks have been completely drained and thoroughly rinsed with water. Read the Material Safety Data Sheet for information on the potential hazards of the working tank solution.
3. Fill the tank with a dilute sodium hypochlorite (NaOCl) solution, such as 2 mL CLOROX (5.25 percent NaOCl) or SUNNY SOL (12.5 percent NaOCl) per litre of water.
4. Allow the hypochlorite solution to remain in the tanks for up to 30 minutes. Longer dwell times can damage plastic or rubber materials. After treatment, dispose of the hypochlorite solution according to local or State disposal regulations.
5. Brush foreign matter from the tanks and racks.
6. Before refilling the tanks, flush them *thoroughly* with water. Small amounts of remaining hypochlorite can have an adverse effect on processing solution activity. Be sure to recirculate rinse water through the recirculation system to remove traces of hypochlorite.

Note: For more information on the recommended methods for cleaning processing tanks contact your Kodak representative.

Disposing of Processing Effluent

Disposing of processing effluent is an important operation of your lab. Effluent from processing using KODAK ECN-2 Kit Chemicals and KODAK ECP-2E Kit Chemicals consists of developer, bleach, de-silvered fixer, prebath, stop bath, final rinse and sound track developer. This effluent is compatible with and can be effectively treated by a municipal secondary waste-water treatment plant.

Because regulations define photographic effluent as an industrial waste discharge, you may need a permit to discharge it to a municipal sewer system.

After efficient silver recovery, the combined effluent from a lab using KODAK ECN-2 Kit Chemicals and KODAK ECP-2E Kit Chemicals should have approximately these characteristics:

pH	6.5 to 9
Temperature	Less than 30°C (86°F)
Silver	0.1 mg/L
Suspended solids	600 mg/L
Oils, greases, detergents	10 mg/L

Concentration of other materials depends on factors such as replenishment and wash rates, type of processor, chemical regeneration, and treatment methods. For more information on the composition of photographic solutions that you use, see the Material Safety Data Sheets. MSDS sheets are available at the Kodak website, www.kodak.com/go/motion. If you need additional help in the U. S. and Canada, call the Kodak Information Center at (800) 242-2424. In other regions, contact Kodak in your country. Each country has its own regulations regarding disposal of processing effluent.

Effluent Disposal

Reduce Processing Effluent—To reduce the environmental impact, keep the discharge of photographic chemicals as low as possible. Some ways that you can accomplish that include:

- Use chemicals designed to have the least environmental impact
- Use correct replenishment rates and check them often
- Avoid making batch discharges, such as tank dumps
- Discharge processing effluent to your sewer slowly by trickling it in with normal non-processing effluent
- De-silver fixer, and final rinse overflow before you discharge it

Other Effluent Disposal Methods—Although most labs discharge their effluent to a municipal waste-treatment plant, restrictions or lack of access to a treatment plant may require some labs to use an off-site disposal service. You can have your processing effluent removed by a licensed disposal company.

Sewering—Direct discharge of untreated processing effluents to receiving waters or to surface drains or storm sewers is not recommended and may not be lawful.

Septic-Tank Systems—The disposal of photo-processing effluent to a septic-tank system requires regulatory approval. Contact your local regulatory agency responsible for ground-water discharges to determine if you can discharge effluent to your septic system and how it should be monitored.

Silver Recovery

Silver is a seasoning product of processing photographic films. Sewer codes may limit the concentration of silver in effluent that may be discharged. To reduce the amount of silver in the effluent, you can de-silver used fixer and final rinse solutions with electrolytic silver-recovery cell and/or silver-recovery cartridges. Electrolytic silver recovery can be done using one of two methods; batch or continuous. The batch method requires a minimum of equipment, but is not as efficient as the continuous method. When a sufficient volume of used fixer is collected, the silver content in the fixer is reduced to 0.5 to 1.0 g/L by an electrolytic cell. Chemicals are then added to reconstitute the fixer for use as a replenisher.

The continuous method includes the electrolytic cell in the fixer recirculation system. The fixer is continuously drawn from the processing machine through the electrolytic cell. The silver content is reduced to 0.5 to 1.0 g/L and the fixer is returned to the machine. To maintain the proper chemical and pH levels, a suitable replenisher is added to the system at a convenient location. This is a very efficient method, but it requires more space and careful control of the current density (i.e., amperes per unit cathode area) of the cell.

Silver Recovery

Silver can be further reduced by utilizing the metallic replacement method in combination with the electrolytic cell. In the metallic replacement method, a metal (usually iron), reacts with the silver thiosulfate and goes into solution. The silver settles out as a solid. To bring the silver into contact with the iron, the used fixer is passed through a container filled with steel wool. The steel wool provides the source of iron to replace the silver. The main advantages of this method are very low initial cost and the simplicity of installation. The disadvantages, compared to the electrolytic method, are that the silver is recovered as a sludge, making it more difficult to determine the exact amount recovered, and the sludge requires more refining than the plate silver obtained from electrolytic methods. The cartridges cannot be reused, and require replacement when exhausted. The effluent from the cartridges contains high amounts of iron. This would be a problem in a locality with a sewer code that limits the iron concentration in the effluent.

Operate your electrolytic-recovery cell according to the manufacturer's instructions. Use for as long an operation time as appropriate. After efficient electrolytic silver recovery followed by metallic replacement cartridges, the silver concentration should be less than 5 mg/L. Discharge the de-silvered effluent with other processing effluent.

KODAK ECN-2 Kit Chemicals

KODAK ECN-2 KIT CHEMICALS

This section includes:

- List of chemicals used for KODAK ECN-2 Kit Chemicals
- Characteristics of KODAK ECN-2 Kit Chemicals
- Processing cycles for KODAK ECN-2 Kit Chemicals
- General Notes
- Mixing Instructions for KODAK ECN-2 Kit Chemicals
- pH Adjustment
- Regeneration

List of Chemicals for KODAK ECN-2 Kit Chemicals

<p>KODAK ECN-2 Kit Prebath and Replenisher</p> <p>Size: 380 x 258 x 288 mm^a Weight: 26.2 kg</p>	<p>Minimum order quantity consists of one 20-litre plastic container. Add water to yield 66.6 litres of replenisher or tank solution.</p>
<p>KODAK ECN-2 Kit Color Developer Starter</p> <p>Size: 330 x 160 x 315 mm^a Weight: 12.36 kg</p>	<p>Minimum order quantity is one case. Each case contains two 5 litre plastic bottles. Each bottle seasons a 100 litre batch of developer tank solution mixed from developer kits. Mixes as follows: 75 litres of developer replenisher plus one 5 litre bottle and adjust to 100 litres.</p>
<p>KODAK ECN-2 Kit Color Developer Replenisher, Part A</p> <p>Size: 380 x 258 x 288 mm^a Weight: 22.37 kg</p>	<p>Minimum order quantity is one 20 litre plastic container. Order two containers of Part A with each case of ECN-2 Kit Color Replenisher, Part B. Each 20 litre Part A mixes with one 5 litre bottle of Part B, to make 100 litres of developer replenisher.</p>

KODAK ECN-2 Kit Chemicals

<p>KODAK ECN-2 Kit Color Developer Replenisher, Part B</p> <p>Size: 330 x 160 x 315 mm Weight: 11.52 kg</p>	<p>Minimum order quantity is one case. Each case consists of two 5 litre bottles of Part B. Order one case Part B for every two containers of Part A.</p>
<p>KODAK ECN-2/ECP-2E Kit Stop Bath and Replenisher</p> <p>Size: 330 x 160 x 315 mm^a Weight: 12.79 kg</p>	<p>Minimum order quantity is one case. Each case consists of two five-litre plastic bottles. Each bottle will yield 100 litres of replenisher solution.</p>
<p>KODAK ECN-2/ECP2-E Kit Bleach and Replenisher</p> <p>Size: 380 x 258 x 288 mm^a Weight: 21.34 kg</p>	<p>Minimum order quantity consists of one 20-litre plastic container. Each container will yield 33.3 litres of replenisher solution.</p>
<p>KODAK ECN-2 Kit Fixer and Replenisher</p> <p>Size: 380 x 258 x 288 mm^a Weight: 27.93 kg</p>	<p>Minimum order quantity consists of one 20-litre plastic container. Each container will yield 66.6 litres of replenisher solution.</p>
<p>KODAK ECN-2/ECP-2E Kit Final Rinse and Replenisher</p> <p>Size: 262 x 195 x 295 mm^a Weight: 6.49 kg</p>	<p>Minimum order quantity is one case. Each case consists of eight one-litre plastic bottles. Each bottle will yield 100 litres of replenisher solution.</p>

a Approximate size and weight.

**Characteristics of
KODAK ECN-2 Kit Chemicals**

Characteristics of KODAK ECN-2 Kit Chemicals

Chemical	Part	Normal Appearance	Comments
Developer Starter		Clear, colorless to very pale yellow	A crystalline precipitate may appear in developer starter that has been kept too long (more than 2 years) and/or exposed to cold temperature. If color and odor are normal, the starter is usable if the crystalline material dissolves upon mixing.
Developer Developer Replenisher	A	Clear, colorless Odorless	A crystalline precipitate may appear in parts that are kept too long (more than 2 years) and/or exposed to cold temperature. If color and odor are normal, Part A is usable if the crystalline material dissolves upon mixing.
	B	Brownish Sulphite odor	Absence of sulfur dioxide odor means the preservative is exhausted. If the solution turns color or becomes opaque, or if there is precipitate, do not use it.
Prebath Prebath Replenisher		Colorless to very pale yellow Odorless	A crystalline precipitate may appear in parts that are kept too long (more than 2 years) and/or exposed to cold temperature. If color and odor are normal, prebath is usable if the crystalline material dissolves upon mixing.
UL Bleach UL Bleach Replenisher		Brownish Odorless	Occasionally you may see a very small amount of light yellow-brown sediment in the mix. This material should not affect processing.

**Characteristics of
KODAK ECN-2 Kit Chemicals**

Chemical	Part	Normal Appearance	Comments
Fixer Fixer Replenisher		Clear, colorless to very pale yellow	Age and/or exposure to high temperature can cause sulfurization. When a white to light yellow sediment forms, the solution becomes more yellow, and a musty odor (sulfur) is noticeable along with the acetic acid odor. Severely degraded fixers may have a large amount of precipitate and an odor of hydrogen sulfide (i.e., rotten-egg odor) and may appear dark. Do not use if it appears this way.
Final Rinse Final Rinse Replenisher		Clear, colorless	

Processing Cycles

There are many different types of kit processors, and they are used under a variety of conditions. Kodak chemicals are designed to get the best results from your lab regardless of its operation.

This section includes information on—

- Time and temperature
- Replenishment rates
- Agitation
- Filtration
- Drying

Film Processing Cycles

The replenishment rates given for the cycle are for a typical mix of KODAK Color Negative Films. Use the rates as starting points; adjust them as required according to your control-plot results.

Processing Cycles

Process Cycles for KODAK ECN-2 Kit Chemicals

Process ECN-2 has three bleaching alternatives, ferricyanide bleach (SR-29), “UL” bleach (SR-33), and persulfate bleach (ST-31). KODAK Kit Chemicals use the “UL” bleach.

“UL” Bleach Sequence

Step	Function
1. Prebath	Softens rem-jet backing for removal.
2. Rem-jet Removal and Rinse	Removes softened rem-jet backing.
3. Developer	Reduces exposed silver-halide grains in all three light-sensitive layers. The developing agent is oxidized by the exposed silver halide, and the oxidation product couples with the particular dye coupler incorporated within each layer to give dye images. A silver image is formed simultaneously at the exposed silver-halide sites.
4. Stop	Stops the development of silver-halide grains, and washes Color Developing Agent, CD-3 from the film.
NOTE: The film can now be handled in white light.	
5. Wash	Removes excess acid stop.
6. Bleach	Converts metallic silver from the yellow-filter layer, and the silver picture image formed during color development to silver-halide compounds that can be removed by the fixer.
7. Wash	Removes residual bleach from the film, preventing contamination of the fixer.
8. Fixer	Converts silver-halide compounds formed in the bleach to soluble silver thiosulfate complex salts that are removed from the film in this fixer and subsequent wash.
9. Wash	Removes the residual soluble silver thiosulfate complex salts and unused hypo from the film.
10. Final Rinse	Prevents water spots and controls biological growths.
11. Dryer	Dries film for subsequent handling.

Processing Cycles

Mechanical Specifications for Process ECN-2 with “UL” Bleach

Process Steps	Temperature ^a		Time min:sec	Replenisher Rate per 100 ft (30.5 m) of 35 mm film ^b	Recirculation (R) Filtration (F) Turbulation (T)
	°C	°F			
Prebath ^c	27 ± 1	80 ± 2	:10	400 mL	R & F @20 to 40 L/min
Rem-jet Removal & Rinse ^d	27 to 38	80 to 100			None
Developer ^{c,e,f}	41.1 ± 0.1	106 ± 0.2	3:00	900 mL	R, F & T
Stop ^g	27 to 38	80 to 100	0:30	600 mL	R & F @20 to 40 L/min
Wash ^h	27 to 38	80 to 100	0:30	1.3 L	None
UL Bleach ^{c,i}	27 ± 1	80 ± 2	3:00	200 mL	R & F @20 to 40 L/min
Wash ^{h,j}	27 to 38	80 to 100	1:00	1.3 L	None
Fixer ^k	38 ± 1	100 ± 2	2:00	600 mL	R & F @20 to 40 L/min
Wash ^l	27 to 38	80 to 100	2:00	270 mL	None
Final Rinse ^m	27 to 38	80 to 100	0:10	400 mL	R & F @20 to 40 L/min
Dryer	Temperature		RH	Air Flow	Time
Impingement	32 to 47	90 to 117	30 to 50%	1000 ft ³ /min	5 to 7 min
Nonimpingement	30 to 38	80 to 100	30 to 50%	1000 ft ³ /min	6 to 8 min

a Fahrenheit temperatures are primary. Celsius temperatures are rounded consistent with process-control requirements.

b For 16 mm film use one-half the 35 mm film replenishment and wash rates. Since processing operations can vary greatly in respect to such factors as film-to-leader ratio, squeegee efficiency, and amount of film processed per unit of time, adjustments in replenisher rates may be required to maintain the recommended tank concentrations. With efficient squeegees, adjustment rates for 35 mm leader will be as low as 20 mL/100 ft.

c Use polypropylene, fiberglass, or bleached cotton as a filter medium in the developer. Viscose rayon is not recommended for prebath, developer, or bleach because of undesirable photographic effects.

d Rem-jet removal time and wash rate will vary with equipment design and method.

e Maintain close control of developer time and temperature, since small deviations can lead to severe contrast mismatch. Use an accurate thermometer for checking the temperature controller variability. The temperature should be uniform throughout the developer tank.

Processing Cycles

- f Design developer racks with submerged rollers and rack-drive assemblies to minimize solution aeration and splashing.
- g Install an exhaust over the stop tank, since developer carried over into the stop generates sulfur dioxide and UL bleach tanks which have an ammonia or acetic acid odor. The exhaust system should produce an air flow of 175 ft³/min (5 m³/min) for every square foot (0.09 m²) of solution surface and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank.
- h Two-stage counter-current washes with squeegees between stages are recommended for efficient washing. The wash rates given in the table assume the use of such two-stage washes. Single-stage washes require substantially greater wash rates.
- i Reconstitute and reuse the bleach to obtain the full economic advantage. See page 41.
- j "UL" Bleach and the wash after the bleach are prone to biogrowth. Addition of PROXEL GXL biocide to the bleach controls this growth. Frequent dumping and changing of this wash tank may prove necessary.
- k Fixer replenisher requirements vary with silver recovery equipment, method and operating conditions. If provision is made for continuous electrolytic desilvering of the recirculated fixer, the silver concentration should be maintained between 0.5 and 1 g/L.
- l The wash rate given in this table assumes that the final wash is composed of four counter-current-wash stages with squeegees between stages.
- m The final rinse contains a wetting agent to promote more efficient squeegeeing of the film strand prior to drying. PROXEL GXL biocide has already been added to control biological growth in the tank.

General Notes

Agitation—Good agitation is important, **especially** during the first few seconds of the developer.

Filtration—Processing solutions and wash water may contain some insoluble materials. If these materials aren't filtered out, they can stick to the film, tank walls, rollers and possibly damage the film. Use filters recommended by the manufacturer of the processor and change them regularly as a part of routine maintenance. Usually, filters with a porosity of 10 to 30 microns are effective for solutions and wash water, and filters with a porosity of 15 microns are effective for incoming water supplies.

Polypropylene is the most acceptable filter core material and one of the least expensive. This material has no photographic effect, but the surfactants used to produce the polypropylene yarns may have an effect on your process. Therefore, monitor your process carefully when you first change filters.

Drying—Keep the film-drying area clean and free of dirt. If the dryer has a filter, check it regularly. If the film is over-dried and has excessive curl, the ambient conditions may be too dry; and the temperature may be reduced or the relative humidity may be increased.

Drying photographic film depends on time in the dryer, the geometry of the dryer, the pattern of air flow and/or impingement on the film, the volume of air flow, the humidity and temperature of the air in the drying cabinet, and the efficiency of the final squeegee before the dryer. The optimum conditions for drying film must be determined for each processor, making allowance for film moisture content and static buildup.

With careful control of the above factors, adequate drying of Process ECN-2 films can be achieved in times as short as 5 1/2 minutes when using an impingement-type dryer. Extending the dryer time to 6 to 8 minutes allows for a wider range of drying conditions and dryer geometry (including nonimpingement drying) and less stringent control of drying conditions. Upon cooling to room temperature after leaving the dryer, the film should have a moisture content in equilibrium with air at 50 percent relative humidity and show minimum curl.

Processing Cycles

Turbulation Specifications—Turbulators are essential in the recirculation system for Process ECN-2 developer to provide uniform film processing. The turbulators are used submerged in the solution and are located in such a way that the recirculated solution impinges uniformly over the full width of the film strand. Turbulation at the emulsion surface must be provided along the film path at a suitable frequency. Backup rollers opposite the turbulators are necessary in most processors when adequate turbulator pressures are used. Precise turbulation design must be determined specifically for a particular processing machine to promote good uniformity of development.

Wash Water Flow Rates—Adequate washing in conjunction with conservation of wash water is a matter of concern for all processors. Ways of reducing wash-water usage while maintaining adequate washing include:

- using multi-stage counter-current-flow washes;
- installing squeegees between wash stages as well as before the wash;
- shutting off wash water when the machine is not transporting film or leader.

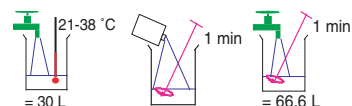
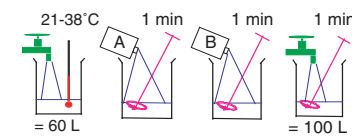
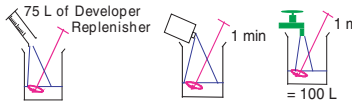
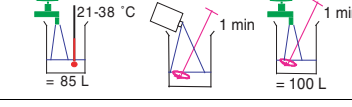
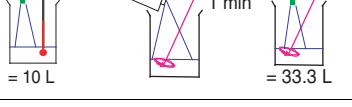
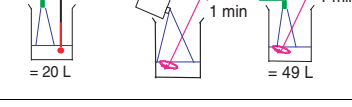
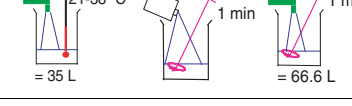
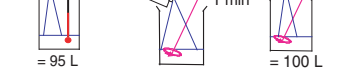
The last alternative can easily be accomplished by installing solenoid valves in the wash-water supply lines that are opened when the machine drive is running. The water savings from the use of squeegees and counter-current stages can be substantial. A three-stage counter-current final wash with squeegees before and after each stage requires approximately 1/25 of the water of a single-stage wash with entrance and exit squeegees. Overflow from one wash step should never be used in any other wash step.

Decreased water flow in the final wash may increase the propensity toward biological growth. Temperature control can also be a concern at lower flow rates. After establishing the final flow rate, check to be sure the process stays within the temperature tolerances specified in the tables above.

The wash-water flow rates in the tables above have been found to be satisfactory in a 75 ft/min (23 m/min) processor, using two-stage counter-current washes (four-stage final wash) with efficient squeegees between stages. The optimum wash rates for a particular installation must be determined after the film transport rate, the number of counter-current stages, and the squeegee efficiencies have been established.

Mixing Instructions

Mixing Instructions for KODAK ECN-2 Kit Chemicals

KODAK ECN-2 Kit	Mixing Instructions	pH at 25°C	One KODAK ECN-2 Kit Makes
Prebath Tank and Replenisher (To make 66.6 L)		10.20 ±0.20 ^a	66.6 L
Developer Replenisher Part A and Part B (To make 100 L)		10.32 ±0.05 ^a	Part A 100 L Part B 2 x 100 L
Color Developer Starter Tank (To make 100 L)		10.25 ±0.05 ^a	2 x 100 L
Stop Bath (To make 100 L)		No Adjustment 0.8 < pH < 1.5	2 x 100 L
Potassium UL Bleach Replenisher (To make 33.3 L)		4.75 ± 0.20 ^b	33.3 L
Potassium UL Bleach Tank (To make 49 L)		4.75 ± 0.20 ^b	49 L
Fixer Tank and Replenisher (To make 66.6 L)		7.75 < pH < 7.93 ^c	66.6 L
Final Rinse (To make 100 L)		No Adjustment	8 x 100 L

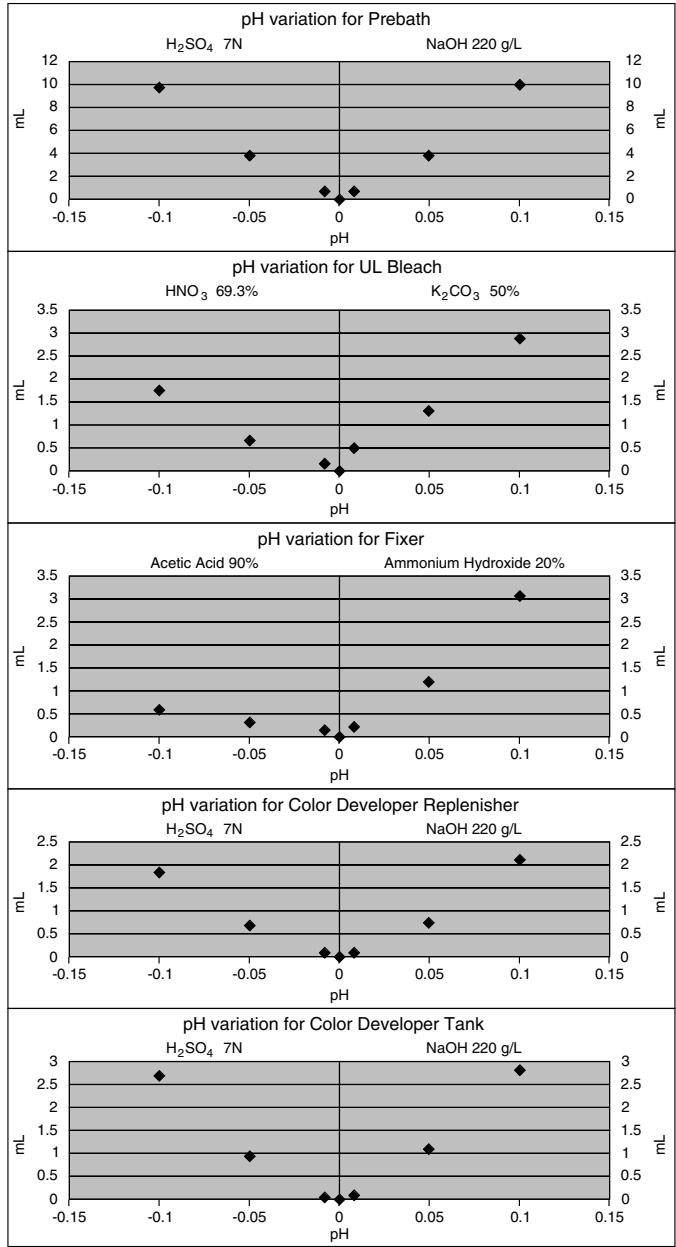
a If necessary, add H₂SO₄ 7N to lower the pH, or NaOH to raise the pH.

b If necessary, add HNO₃ to lower the pH, or K₂CO₃ to raise the pH.

c If necessary, add 90% acetic acid to lower the pH, or 20% ammonium hydroxide to raise the pH.

pH Adjustment

pH Adjustment



F009_0379DC

Regeneration – UL Bleach Additions

Procedure to Reconstitute the UL Bleach

Applies to the KODAK ECN-2/ECP-2E Kit Bleach and Replenisher.

1. Collect the overflow

2. Analyze Fe²⁺.

If concentration of Fe²⁺ is less than 0.5 g/L, go to step 3.

If not, aerate the overflow until the concentration of Fe²⁺ drops below 0.5 g/L.

Analyze total iron.

3. Use the equation below to determine the number of litres of UL bleach concentrate which is to be added to the overflow.

If A = litres of tank overflow collected

B = g/L of Fe analyzed in tank overflow (Fe = total iron)

C = litres of UL bleach concentrate needed

D = 15 g/L which is the amount of iron in the UL bleach concentrate

Z = g/L of Fe specs in the replenisher with:

Z = 7.5 g/L for the ECN-2 bleach

$$C = A (7.5 - B)/7.5$$

$$(A * B) + (C * D) = Z (A + C)$$

$$\text{Fe in overflow} + \text{Fe in UL bleach concentrate} = \text{Fe in new bleach made}$$

Example: (for ECN-2 Kit)

A = 300 L of overflow collected

B = 4.8 g/L total iron analyzed in overflow

C = to be calculated

D = 15 g/L

Z = 7.5 g/L

Therefore

$$C = 108 \text{ L}$$

Regeneration

Regenerating UL House Bleach

Replenishment rates are those prevailing for each process. For Process ECN-2 use 200 mL for 30.5 m of 35 mm film, and for Process ECP-2E use 400 mL per 30.5 m of 35 mm film. The procedure to reconstitute the UL house bleach is exactly the same as the one to reconstitute the UL Bleach for Process ECP-2E.

KODAK ECN-2 Kit Fixer Used Directly and Without Dilution as Replenisher

Summary: You can use KODAK ECN-2 Kit Fixer and Replenisher directly as a machine replenisher (undiluted). The only modification needed is to adjust fixer replenisher flow rate. To use the fixer directly without dilution, the fixer replenisher flow rate should be changed from 23 L/h (machine speed 1680 m/h) to 1 L/h. These recommendations only apply to KODAK Kit Chemicals.

Advantages: KODAK ECN-2 Kit Fixer and Replenisher used as replenisher without mixing permits reduction of the normal flow rate of fixer replenisher by 23x without any sensitometric shift. Treat the overflow in the same way for de-silvering, resin treatment, etc. Using this procedure will reduce mixing errors for fixer/replenisher.

Limitations: When using this system the bromide and iodide level must be monitored. The fixer may be used without sensitometric effect with a bromide level up to 35 g/L and an iodide level up to 2 g/L.

The only adjustment needed is to the pH and sulphite :

Adjust the pH to 6.5 when the pH is under 5.5.

Adjust the sulphite to 20 g/L when the sulphite is under 15 g/L.

The silver level should be maintained between 0.3 and 1.5 g/L.

KODAK ECP-2E Kit Chemicals

KODAK ECP-2E KIT CHEMICALS

This section includes:

- List of chemicals used for KODAK ECP-2E Kit Chemicals
- Characteristics of KODAK ECP-2E Kit Chemicals
- Processing cycles for KODAK ECP-2E Kit Chemicals
- General Notes
- Mixing Instructions for KODAK ECP-2E Kit Chemicals
- pH Adjustment
- Regeneration

List of Chemicals for KODAK ECP-2E Kit Chemicals

<p>KODAK ECP-2E Kit Color Developer Starter</p> <p>Size: 330 x 160 x 315 mm^a Weight: 11.73 kg</p>	<p>Minimum order quantity is one case. Each case contains two 5 litre plastic bottles. Each case seasons a 100 litre batch of developer tank solution, mixed from developer kits. Mixes as follows: 52 litres of developer replenisher plus two 5 litre bottles and adjust to 100 litres.</p>
<p>KODAK ECP-2E Kit Color Developer Replenisher, Part A</p> <p>Size: 380 x 258 x 288 mm^a Weight: 23.04 kg</p>	<p>Minimum order quantity is one 20 litre plastic container. Order one container Part A with each case of Part B. Each 20 litre Part A mixes with two 5 litre bottles of Part B to make 100 litres of developer replenisher.</p>
<p>KODAK ECP-2E Kit Color Developer Replenisher, Part B</p> <p>Size: 330 x 160 x 315 mm^a Weight: 11.24 kg</p>	<p>Minimum order quantity is one case. One case consists of two 5 litre plastic bottles of Part B. Order one case Part B with each container Part A.</p>
<p>KODAK ECN-2/ECP-2E Kit Stop Bath and Replenisher</p> <p>Size: 330 x 160 x 315 mm^a Weight: 12.9 kg</p>	<p>Minimum order quantity is one case. Each case consists of two five-litre plastic bottles. Each bottle will yield 100 litres of replenisher solution.</p>

KODAK ECP-2E Kit Chemicals

<p>KODAK ECN-2/ECP-2E Kit Bleach and Replenisher</p> <p>Size: 380 x 258 x 288 mm^a Weight: 21.34 kg</p>	<p>Minimum order quantity consists of one 20-litre plastic container. Each container will yield 33.3 litres of replenisher solution.</p>
<p>KODAK ECP-2E Kit Fixer and Replenisher</p> <p>Size: 380 x 258 x 288 mm^a Weight: 28.35 kg</p>	<p>Minimum order quantity consists of one 20-litre plastic container. Each container will yield 66.6 litres of replenisher solution.</p>
<p>KODAK ECN-2/ECP-2E Kit Final Rinse and Replenisher</p> <p>Size: 262 x 195 x 295 mm^a Weight: 6.49 kg</p>	<p>Minimum order quantity is one case. Each case consists of eight 1 litre plastic bottles. Each bottle will yield 100 litres of replenisher solution.</p>

a Approximate size and weight.

Characteristics of KODAK ECP-2E Kit Chemicals

Characteristics of KODAK ECP-2E Kit Chemicals

Chemical	Part	Normal Appearance	Comments
Developer Starter		Clear, colorless to very pale yellow	A crystalline precipitate may appear in developer starter that is kept too long (more than 2 years) and/or exposed to cold temperature. If color and odor are normal, the developer starter is usable if the crystalline material dissolves upon mixing.
Developer Developer Replenisher	A	Clear, colorless Odorless	A crystalline precipitate may appear in parts that are kept too long (more than 2 years) and/or exposed to cold temperature. If color and odor are normal, Part A is usable if the crystalline material dissolves upon mixing.
	B	Reddish Sulphite odor	Absence of sulfur dioxide odor means the preservative is exhausted. If the solution turns color or becomes opaque, or if there is precipitate, do not use it.
UL Bleach UL Bleach Replenisher		Brownish Odorless	Occasionally you may see a very small amount of light yellow-brown sediment in the mix. This material should not affect processing.
Fixer Fixer Replenisher		Clear, colorless to very pale yellow	Age and/or exposure to high temperature can cause sulfurization. When a white to light yellow sediment forms, the solution becomes more yellow, and a musty odor (sulfur) is noticeable along with the acetic acid odor. Severely degraded fixers may have a large amount of precipitate and an odor of hydrogen sulfide (i.e., rotten-egg odor) and may appear dark. Do not use if it appears this way.
Final Rinse Final Rinse Replenisher		Clear, colorless	

Processing Cycles

Processing Cycles for KODAK Kit Chemicals

There are many different types of kit processors, and they are used under a variety of conditions. Kodak chemicals are designed to get the best results from your lab regardless of its operation.

This section includes:

- Processing cycles for KODAK ECP-2E Kit Chemicals

With information on—

Time and temperature
Replenishment rates
Agitation
Filtration
Drying

Film Processing Cycles

The replenishment rates given for the cycle are for a typical mix of KODAK Color Print Films. Use the rates as starting points; adjust them as required according to your control-plot results.

**Process Cycles for KODAK ECP-2E Kit
Chemicals**

“UL” Bleach Sequence	
Step	Function
1. Developer	Reduces exposed silver-halide grains in all three light-sensitive layers. The developing agent is oxidized by the exposed silver halide, and the oxidation product couples with the particular dye coupler incorporated within each layer to give dye images. A silver image is formed simultaneously at the exposed silver-halide sites.
2. Stop	Stops the development of silver-halide grains, and washes Color Developing Agent, CD-2 from the film.
NOTE: The film can now be handled in white light.	
3. Wash	Removes excess acid stop.
4. First Fixer	Converts the unexposed and undeveloped silver halide to soluble complex silver thiosulfate compounds that are removed in this fixer and subsequent wash.
5. Wash	Removes residual silver thiosulfate complex compounds that were not removed from the film in the first fixer.
6. Bleach UL Bleach	Converts the metallic silver from both the sound track image and picture image that was formed during color development to silver-halide compounds.
7. Wash	Removes the excess bleach from the film.
8. Sound Track Developer	Re-develops the analog sound track to silver.
9. Spray Rinse	Removes the excess sound track developer.
10. Second Fixer	Converts the silver halide to soluble complex silver thiosulfate compounds.
11. Wash	Removes the residual thiosulfate complex compounds from the film.
12. Final Rinse	Improves the drying uniformity.
13. Dryer	Dries the film.

Processing Cycles

Mechanical Specifications for Process ECP-2E with “UL” Bleach

Process Steps	Temperature ^a		Time min:sec	Replenisher Rate per 100 ft (30.5 m) of 35 mm film ^b	Recirculation (R) Filtration (F) Turbulation (T)
	°C	°F			
Developer ^{c,d,e}	36.7 ±0.1	98 ±0.2	3:00	690 mL	R, F & T @ 125 to 175 L/min
Stop ^f	27 ±1	80 ±2	0:40	770 mL	R & F @ 40 to 60 L/min
Wash ^g	27 ±3	80 ±5	0:40	1.2 L	None
First Fixer ^h	27 ±1	80 ±2	0:40	200 mL	R & F @ 40 to 60 L/min
Wash ^g	27 ±3	80 ±5	0:40	1.2 L	None
UL Bleach ⁱ	27 ±1	80 ±2	1:00	400 mL	R & F @ 40 to 60 L/min
Wash ⁱ	27 ±3	80 ±5	0:40	1.2 L	None
Dry film surface before sound track developer application					
Sound track Developer	Ambient		:10 - :20		None
Spray Rinse	27 ±3	80 ±5	:01 - :02		None
Second Fixer ^h	27 ±1	80 ±2	0:40		R & F @ 40 to 60 L/min
Wash ^j	27 ±3	80 ±5	1:00	1.2 L	None
Final Rinse	27 ±3	80 ±5	0:10	400 mL	R & F @ 40 to 60 L/min
Dryer	Temperature		RH	Air Flow	Time
Impingement	57	135	15 to 25%	5000 ft ³ /min	3 to 5 min
Nonimpingement	43 to 49	110 to 120	15 to 25%	5000 ft ³ /min	5 to 7 min
35 mm Edgewax, 16 and 8 mm Full coat lubrication					

a Fahrenheit temperatures are primary. Celsius temperatures are rounded consistent with process-control requirements.

b For 16 mm film use one-half the 35 mm film replenishment and wash rates. Since processing operations can vary greatly in respect to such factors as film-to-leader ratio, squeegee efficiency, and amount of film processed per unit of time, adjustments in replenisher rates may be required to maintain the recommended tank concentrations. With efficient squeegees, adjustment rates for 35 mm leader will be as low as 20 mL/100 ft.

c Use polypropylene, fiberglass, or bleached cotton as a filter medium in the developer. Viscose rayon is not recommended for developer because of undesirable photographic effects.

d Maintain close control of developer time and temperature, since small deviations can lead to severe contrast mismatch. Use an accurate thermometer for checking the temperature controller variability. The temperature should be uniform throughout the developer tank.

- e Design developer racks with submerged rollers and rack-drive assemblies to minimize solution aeration and splashing.
- f Install an exhaust over the stop tank, since developer carried over into the stop generates sulfur dioxide. The exhaust system should produce an air flow of 175 ft³/min (5 m³/min) for every square foot (0.09 m²) of solution surface, and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank.
- g The wash rate is for two counter-current stages with squeegees between stages.
- h Fixer replenishment requirements vary with silver recovery equipment, method and operating conditions. If provision is made for continuous electrolytic desilvering of the recirculated fixer, the silver concentration should be maintained between 0.5 and 1 g/L. See page 15 for details. The fixer and replenisher must be kept separate from other processes. Cascading the first fixer overflow into the second fixer helps conserve chemicals.
- i Reconstitute and reuse the bleach to obtain the full economic advantage. See page 41.
- j The wash rate given in the table assumes that the final wash and bleach wash are composed of three counter-current wash stages with squeegees between stages.

General Notes

Agitation—Good agitation is important, **especially** during the first few seconds of the developer.

Filtration—Processing solutions and wash water may contain some insoluble materials. If these materials aren't filtered out, they can stick to the film, tank walls, rollers and possibly damage the film. Use filters recommended by the manufacturer of the processor and change them regularly as a part of routine maintenance. Usually, filters with a porosity of 10 to 30 microns are effective for solutions and wash water, and filters with a porosity of 15 microns are effective for incoming water supplies.

Polypropylene is the most acceptable filter core material and one of the least expensive. This material has no photographic effect, but the surfactants used to produce the polypropylene yarns may have an effect on your process. Therefore, monitor your process carefully when you first change filters.

Drying—Keep the film-drying area clean and free of dirt. If the dryer has a filter, check it regularly. If the film is over-dried and has excessive curl, the ambient conditions may be too dry; and the temperature may be reduced or the relative humidity may be increased.

Drying photographic film depends on time in the dryer, the geometry of the dryer, the pattern of air flow and/or impingement on the film, the volume of air flow, the humidity and temperature of the air in the drying cabinet, and the efficiency of the final squeegee before the dryer. The optimum conditions for drying film must be determined for each processor, making allowance for film moisture content and static buildup.

With careful control of the above factors, adequate drying of Process ECP-2E films can be achieved in times as short as 5 1/2 minutes when using an impingement-type dryer. Extending the dryer time to 6 to 8 minutes allows for

Processing Cycles

a wider range of drying conditions and dryer geometry (including nonimpingement drying) and less stringent control of drying conditions. Upon cooling to room temperature after leaving the dryer, the film should have a moisture content in equilibrium with air at 50 percent relative humidity and show minimum curl.

Turbulation Specifications—Turbulators are essential in the recirculation system for Process ECP-2E developer to provide uniform film processing. The turbulators are used submerged in the solution and are located in such a way that the recirculated solution impinges uniformly over the full width of the film strand. Turbulation at the emulsion surface must be provided along the film path at a suitable frequency. Backup rollers opposite the turbulators are necessary in most processors when adequate turbulator pressures are used. Precise turbulation design must be determined specifically for a particular processing machine to promote good uniformity of development.

Wash Water Flow Rates—Adequate washing in conjunction with conservation of wash water is a matter of concern for all processors. Ways of reducing wash-water usage while maintaining adequate washing include:

- using multi-stage counter-current-flow washes;
- installing squeegees between wash stages as well as before the wash;
- shutting off wash water when the machine is not transporting film or leader.

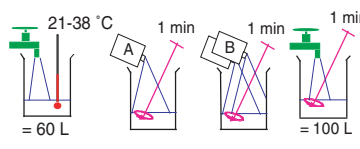
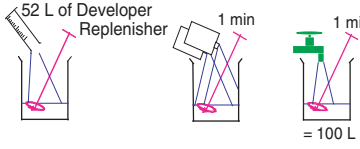
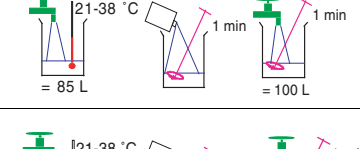
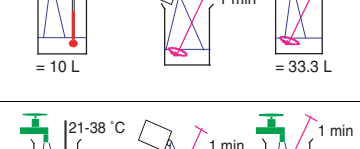
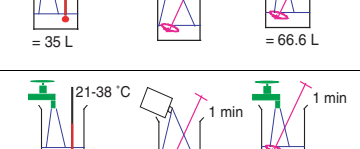
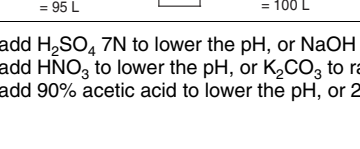
The last alternative can easily be accomplished by installing solenoid valves in the wash-water supply lines that are opened when the machine drive is running. The water savings from the use of squeegees and counter-current stages can be substantial. A three-stage counter-current final wash with squeegees before and after each stage requires approximately 1/25 of the water of a single-stage wash with entrance and exit squeegees. Overflow from one wash step should never be used in any other wash step.

Decreased water flow in the final wash may increase the propensity toward biological growth. Temperature control can also be a concern at lower flow rates. After establishing the final flow rate, check to be sure the process stays within the temperature tolerances specified in the tables above.

The wash-water flow rates in the tables above have been found to be satisfactory in a 165 ft/min (50 m/min) processor, using two-stage counter-current washes (three-stage final wash) with efficient squeegees between stages. The optimum wash rates for a particular installation must be determined after the film transport rate, the number of counter-current stages, and the squeegee efficiencies have been established.

Mixing Instructions

Mixing Instructions for KODAK ECP-2E Kit Chemicals

KODAK ECP-2E Kit	Mixing Instructions	pH at 25°C	One KODAK ECP-2E Kit Makes
Developer Replenisher Part A and Part B (To make 100 L)		11.20 ±0.05 ^a	Part A 100 L Part B 100 L
Color Developer Starter Tank (To make 100 L)		10.59 ±0.05 ^a	100 L
Stop Bath (To make 100 L)		No adjustment 0.8 < pH < 1.5	2 x 100 L
Potassium UL Bleach Tank and Replenisher (To make 33.3 L)		4.75 ± 0.20 ^b	33.3 L
Fixer Tank and Replenisher (To make 66.6 L)		6.5 < pH < 6.7 ^c	66.6 L
Final Rinse (To make 100 L)		No adjustment	8 x 100 L

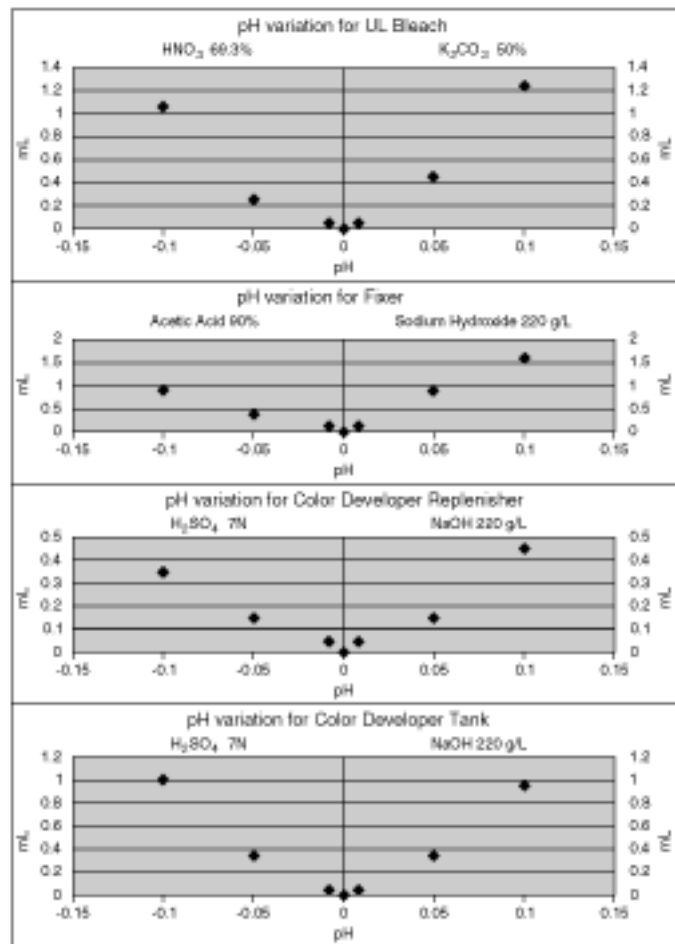
a If necessary, add H₂SO₄ 7N to lower the pH, or NaOH to raise the pH.

b If necessary, add HNO₃ to lower the pH, or K₂CO₃ to raise the pH.

c If necessary, add 90% acetic acid to lower the pH, or 20% ammonium hydroxide to raise the pH.

pH Adjustment

pH Adjustment



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Regeneration – UL Bleach Additions

Procedure to Reconstitute the UL Bleach

Applies to the KODAK ECN-2/ECP-2E Kit Bleach and Replenisher.

1. Collect the overflow

2. Analyze Fe²⁺.

If concentration of Fe²⁺ is less than 0.5 g/L, go to step 3.

If not, aerate the overflow until the concentration of Fe²⁺ drops below 0.5 g/L.

Analyze total iron.

3. Use the equation below to determine the number of litres of UL bleach concentrate which is to be added to the overflow.

If A = litres of tank overflow collected

B = g/L of Fe analyzed in tank overflow (Fe = total iron)

C = litres of UL bleach concentrate needed

D = 15 g/L which is the amount of iron in the UL bleach concentrate

Z = g/L of Fe specs in the replenisher with:

Z = 10 g/L for the ECP-2E bleach

$$C = A(10 - B)/5$$

$$(A * B) + (C * D) = Z(A + C)$$

Fe in overflow + Fe in UL bleach concentrate = Fe in new bleach made

Example: (for ECP-2E Kit)

A = 300 L of overflow collected

B = 4.8 g/L total iron analyzed in overflow

C = to be calculated

D = 15 g/L

Z = 10 g/L

Therefore

$$C = 312 \text{ L}$$

Regeneration

Regenerating UL House Bleach

Replenishment rates are those prevailing for each process. For Process ECN-2 use 200 mL for 30.5 m of 35 mm film, and for Process ECP-2E use 400 mL per 30.5 m of 35 mm film. The procedure to reconstitute the UL house bleach is exactly the same as the one to reconstitute the UL Bleach for Process ECP-2E.

PROCESS MONITORING AND TROUBLESHOOTING

This section describes:

- Introduction
- Terms used in process monitoring and troubleshooting
- How to monitor your process
- Storing, handling, and processing control strips
- Processing control strips
- Plotting control-strip densities - Process ECN-2
- Plotting control-strip densities - Process ECP-2E
- Changing to a new batch of control strips
- Troubleshooting your process

Introduction

If you mix chemicals properly and use the correct settings for the process cycles, your process should plot in control, and your lab will produce high-quality customer orders. Deviations from standard conditions for the processing solutions, time, temperature, agitation, replenishment, filtration, wash water, or drying can cause processing problems. Deviations from normal conditions produce either under- or over-development.

- *Under-development* in the ECN-2 or ECP-2E process will result in a decrease in density in your control strips for your processes. It may also produce a color shift, depending on the cause of the problem.
- *Over-development* will produce an increase in density in your control strips. It may also produce a color shift, depending on the cause of the problem.

When the control plot shows a problem, you may also see the problem in customer orders. However, remember that customer orders reflect the entire system—i.e., Process ECN-2 and Process ECP-2E. For example, too much activity in Process ECN-2 (over-development of negative) or too little activity in Process ECP-2E may cause the prints to be light. Checking only the control plots may not always isolate the problem, because using the wrong control strip or improperly stored strips may give false information. Therefore, to find the cause of any problem, check the control plots of your ECN and ECP processes and visually review appropriate customer orders.

Process Monitoring Terms

Terms in Process Monitoring and Troubleshooting

The following terms are frequently used in process monitoring.

Action Limits—The action limits are the boundaries of the desired operating range of the process. As long as the density values remain between the upper and lower action limits, your process is operating correctly. If a density value exceeds the action limit, it is an “early warning.” You can still safely process customer work, but you should check for the cause of the shift and correct it. When the density values plot between the upper and lower action limits (i.e., the “aim zone”), your process is in control.

Aim Values—These are the values to which you compare your control strip densities. To obtain aim values, read the reference strip densities; then apply the correction factors to the density readings. Enter these values in the spaces provided on the left side of your control chart.

Color-Balance Spread Limits—A color spread is the density difference between the two most widely separate densities of the HD – LD plot. If the process exceeds the color spread limit, stop processing customer work, and take corrective action.

Control Limits—The control limits define the maximum tolerances that are acceptable for processing customer work. If any density value of your process plots beyond the control limit, the process is out of control, and results will be unsatisfactory for color, density, and/or contrast. When any density value plots beyond the control limits, stop processing customer work until you find the cause of the shift and correct it.

Control Strips—These are precisely exposed strips used to monitor your process.

Correction Factors—Numbers used to adjust the densities of the reference strip to obtain aim values. They are printed in the instruction sheet packaged with each box of control strips. Correction factors usually differ for each code number.

Reference Strips—This is a control strip that is precisely processed by Kodak at standard conditions. A reference strip is packaged with each batch of control strips. To obtain aim values, measure the reference-strip densities and apply the correct factors for that batch of control strips.

Process Monitoring Terms

Tolerances and Limits—Tolerances and limits are density variations allowed before you must take corrective action; they include action and control limits. See KODAK Publication H-24 for more information on limits and adjustment tolerances.

Tolerance Limits

Process ECN-2

Step	D-min	LD	MD	HD	HD – LD	CB Spread Limits ^a	
	dot	14	8	4	4 – 14	LD	HD – LD
Action Limits	+ 0.03	±0.03	±0.05	±0.06	±0.05	0.03	0.05
Control Limits	+ 0.05	±0.05	±0.07	±0.08	±0.07	0.05	0.07

Process ECP-2E

Step	D-min	LD	MD	HD	HD – LD	CB Spread Limits ^a	
	dot	14	11	8	8 – 11	MD	HD – MD
Action Limits	+ 0.03	±0.06	±0.13	±0.20	±0.13	0.10	0.10
Control Limits	+ 0.05	±0.08	±0.15	±0.25	±0.15	0.13	0.13

^a The CB spread limits are the maximum allowable density differences between plotted control values of any two colors in a step (i.e. red-green, green-blue, or blue-red).

Process Monitoring Methods

How to Monitor Your Process

To begin process monitoring, you will need—

- KODAK VISION3 Color Negative Control Strips, Process ECN-2
- KODAK VISION Color Print Control Strips, Process ECP-2E
- An electronic densitometer equipped with Status M filters to read the ECN-2 control strips and Status A filters to read the ECP-2E control strips
- KODAK Process Record Form H-24F, Y-55, or similar graph paper
- Red, green, and blue pencils

KODAK Control Strips Are the Basic Control Material

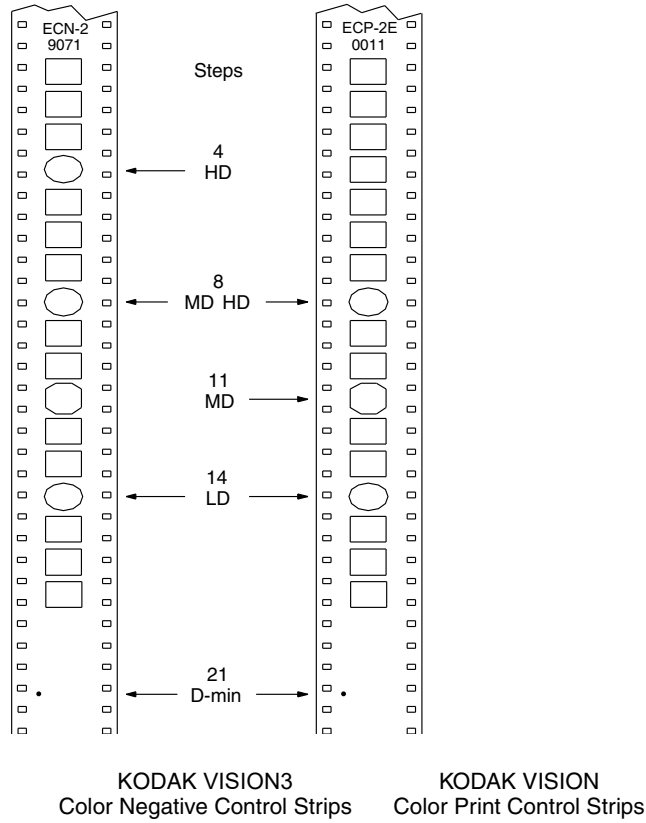
KODAK Control Strips are available for monitoring your processes. For color negative film that uses the ECN-2 process, use KODAK VISION3 Color Negative Control Strips, Process ECN-2. For color print film that uses the ECP-2E process, use KODAK VISION Color Print Control Strips, Process ECP-2E.

KODAK VISION3 Color Negative Control Strips, Process ECN-2, are packaged in 100-foot rolls containing at least 120 exposures, and a processed reference strip. The exposures on the roll are spaced at 9.5-inch intervals. Each exposure has 21 gray-scale steps at 0.20 log H increments ($2/3$ camera stop). See the figure on page 47.

KODAK VISION Color Print Control Strips, Process ECP-2E, are packaged in 100-foot rolls containing at least 120 exposures, and a processed reference strip. The exposures on the roll are spaced at 9.5 inch intervals. Each exposure has 21 gray-scale steps at 0.15 log H increments ($1/2$ camera stop). See the figure on page 47.

Control Strips

Process Control Strips



The reference strip accompanying each roll of control strips was exposed along with all other control strips; it was then processed under specified well-controlled conditions. An instruction sheet enclosed with the package contains process deviation (correction) factors, if they are required, to determine your laboratory process aim numbers. A four-digit code number appearing on the carton, can, control strips, reference strips, and instruction sheet, identifies each production batch of strips.

Storing, Handling and Processing Control Strips

Storing and Handling Control Strips

Store unused control strips at -18°C (0°F) or lower. Handle unprocessed strips in total darkness. Remove only a day's supply from one package at a time; reseal and return the package to the freezer as quickly as possible. (**Do not** keep the package out of the freezer for more than 1 hour per day.) Store your daily supply of control strips in a light-tight container at room temperature. At the end of the day, discard any unprocessed strips that you removed from storage.

A highly recommended way to prepare the strips for processing is to break down the entire batch (or at least one 30.5-metre [100-foot] roll), into individual containers (35 mm film cassette containers are ideal) and then place all containers into the freezer until needed. They should require very little warm-up time prior to processing.

There are no physical indicators on the exposed control strip roll, such as dimples or notches denoting the location of the exposures. To be sure you have a complete 21-step exposure, the control film length to be processed should be at least 690 mm (27 inches). This yields about 45 strips from each 30.5-metre (100-foot) roll.

Handle control strips by the edges to prevent fingerprints and surface damage. If film sticking, static marking, or moisture mottle occurs, allow the strips to warm up to room temperature before you process them. Store the reference strip in its envelope when you are not using it.

It is very important to always use fresh control strips to ensure consistency in process monitoring. Because the latent image on all film changes to some degree with age, each control strip package is dated at the time of manufacture, and the strips must not be used beyond the expiration date indicated. This expiration date is also very important when ordering the control strips, to prevent over-ordering. Initially, you should order a quantity that will last well within the expiration date of that particular batch. However, with some experience of quantity needs, it is always advantageous to order as large a supply as possible of the same batch (code) number, to continue on the same aim numbers as long as possible.

Plotting Control-Strip Densities

Processing Control Strips

Each time you process a control strip, position it in the same location in your processor. Process a control strip—

- At the beginning of the day or shift, before processing customer work
- At regular intervals with customer work
- At the end of the day or shift

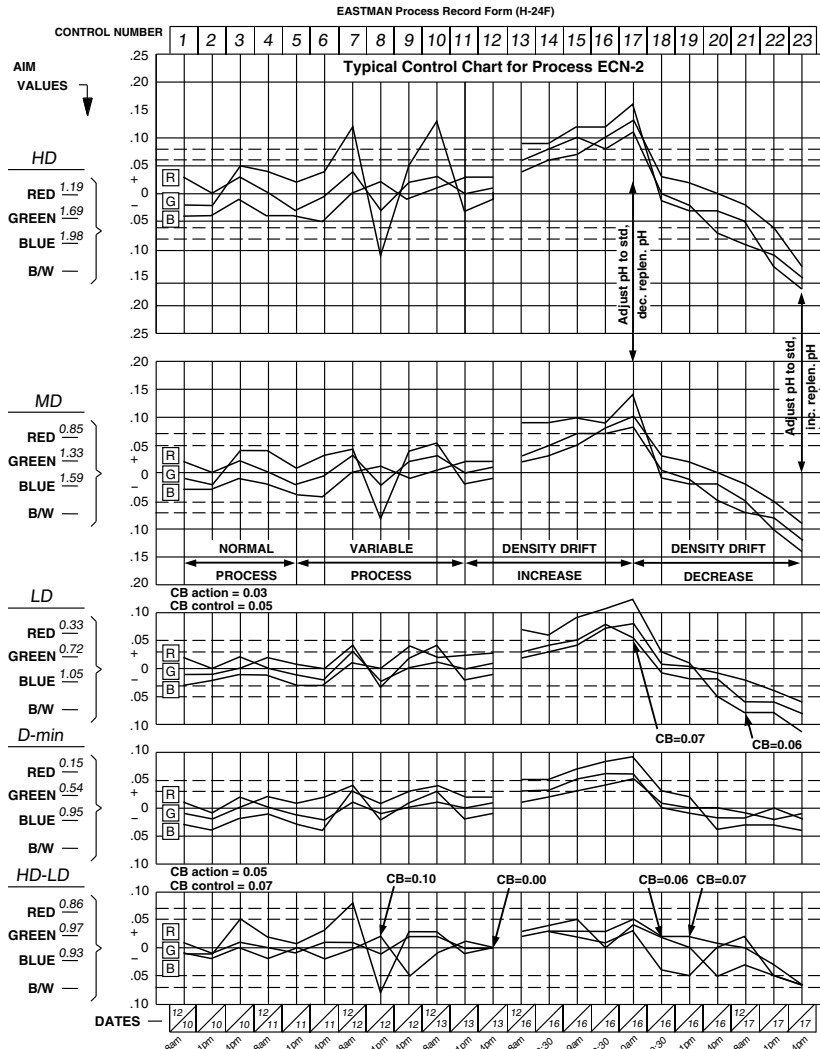
The 30.5-metre (100-foot) roll of control strips is wound with the emulsion side in and with the low density end of each strip toward the outside of the roll. The low density end comes off the roll first; enter it into the processor first. However, always have the strip enter the processor in an identical direction for each process run, to minimize possible directional process effects.

Plotting Control-Strip Densities

Create a control chart by using the KODAK Process Record Form H-24F, Y-55, or similar graph paper. Follow the procedure given below. Your chart will look like the example on page 50. For more information about setting up a control plot and using control strips, see KODAK Publication H-24, *Processing KODAK Motion Picture Films*.

Plotting Control-Strip Densities

Typical Control Chart for Process ECN-2



PROCESS ECN-2
 MACHINE # 1
 Reference Strip Code No. 7121

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 KODAK Publication No. H-24F Kodak and Eastman are trademarks.



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Plotting Control-Strip Densities

1. Draw in the action and control limits given in the appropriate table on page 45. Use black for the action limits and red for the control limits.
2. Allow the reference strip to warm up to room temperature (about 15 minutes) and then remove it from its envelope. Exposing a frozen strip to warm, moist air can cause low readings, particularly in the higher density patches.
3. Measure the red, green and blue densities in the center of each patch with a precision electronic densitometer. Do not move the strip as you make the density readings or you may affect the precision and reliability of the measurements. If you have several boxes of strips with the same code number, average the readings of all the reference strips. A code number on the box label, the reference strips and the control strips identifies each batch. For Process ECN-2, measure the densities of the reference strips identified in the table below. Set your densitometer to the transmission mode, and use the Status M filters. For Process ECP-2E, measure the densities of the reference strips identified in the table below. Set your densitometer to the transmission mode, and use the Status A filters.

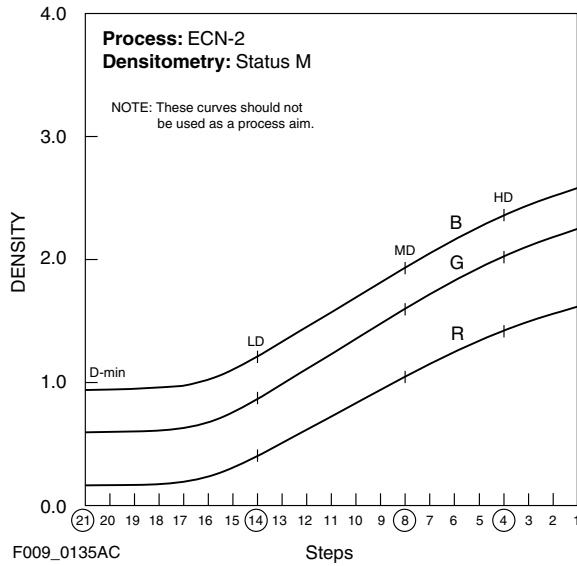
Control Steps

Process ECN-2	Process ECP-2E
D-min (opposite dot)	D-min (opposite dot)
LD (Step 14)	LD (Step 14)
MD (Step 8)	MD (Step 11)
HD (Step 4)	HD (Step 8)
HD – LD (Steps 4-14)	HD – MD (Steps 8-11)
(Use Status M Densitometry)	(Use Status A Densitometry)

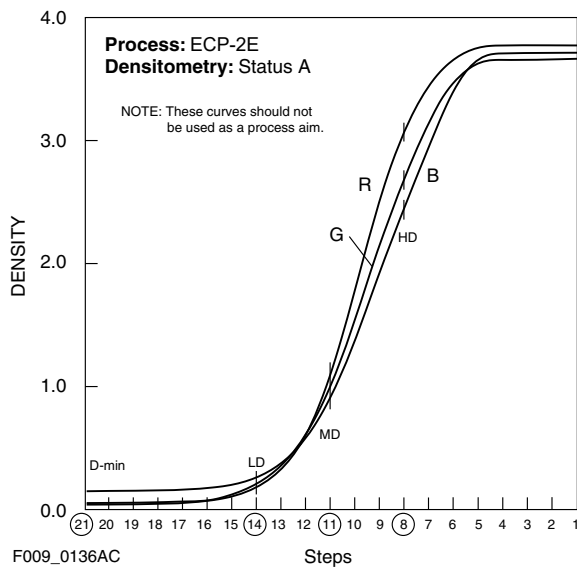
The control parameters are: a base or minimum density (D-min); a low density step (LD), which represents the characteristic curve toe; a film speed step, which is the mid-density (MD); a high density (HD) step, representing the picture blacks but not necessarily the maximum density (D-max); and a calculated color contrast and balance parameter (CB). The contrast parameter is the difference between a high density and the designated lower density for a particular product, and is a very good indicator of process performance. The color balance parameter (CB) is the density spread or difference between any two colors of an individual step. The control steps for Processes ECN-2 and ECP-2E are shown in the figures on page 52.

Plotting Control-Strip Densities

KODAK VISION3 Color Negative Film



KODAK VISION Color Print Film



- To calculate aim values, apply the correction factors supplied in the instruction sheet packaged with each box of control strips to the reference

Plotting Control-Strip Densities

strip densities. If you averaged the reference strip readings from several boxes of the same code number, apply the correction factors to the average. These corrected density values are the aim values for that batch of control strips. Record them in the proper spaces in the left margin of Form H-24F or Y-55.

- To obtain the HD – LD aim values, subtract the adjusted LD values from the adjusted HD values.
- To obtain the HD – MD aim values, subtract the adjusted MD values from the adjusted HD values

For an example of how to calculate aims value see the table below, *Typical Correction Factors for Process ECN-2*, and the table on page 54, *Calculating Aim Values for Process ECN-2*.

Typical Correction Factors for Process ECN-2

Code Number 5122	Filter in Densitometer		
	Red	Green	Blue
D-min (opposite dot)	- 0.01	- 0.01	0.00
LD (Step 14)	0.00	0.00	+ 0.01
MD (Step 8)	0.01	+ 0.03	+ 0.03
HD (Step 4)	+ 0.02	+ 0.02	+ 0.04

Plotting Control-Strip Densities

Calculating Aim Values for Process ECN-2

		Ref. Strip Dens. Reading	Corr. Factor	Aim Values
D-min	R	0.16	- 0.01	0.15
	G	0.55	- 0.01	0.54
	B	0.95	0.00	0.95
LD	R	0.33	0.00	0.33
	G	0.72	0.00	0.72
	B	1.04	+ 0.01	1.05
MD	R	0.84	+ 0.01	0.85
	G	1.30	+ 0.03	1.33
	B	1.56	+ 0.03	1.59
HD	R	1.17	+ 0.02	1.19
	G	1.67	+ 0.02	1.69
	B	1.94	+ 0.04	1.98
HD – LD	R	0.84	+ 0.02	0.86
	G	0.95	+ 0.02	0.97
	B	0.90	+ 0.03	0.93

Note: Using Values from *Typical Correction Factors for Process ECN-2* on page 53, and *KODAK VISION3 Color Negative Film* on page 52.

5. Process a control strip and measure the same patches that you measured in step 3.
6. Calculate the variations from aim by subtracting the aim densities from your control-strip densities. Plot the variations on your control chart.
 - Plot differences that are **larger** than the corresponding aim values (+ values) **above** the aim line.
 - Plot differences that are **smaller** than the aim values (– values) **below** the aim line.
7. If any of the variations from aim plot beyond the action or control limits, process another control strip. If the second strip confirms the results of the first strip, determine the cause of the problem.
8. Whenever you take corrective action, process another control strip to confirm that the change you made returned the process to control before you resume normal processing. Make a note on your control chart of what corrective action you took.

Changing to a New Batch of Control Strips

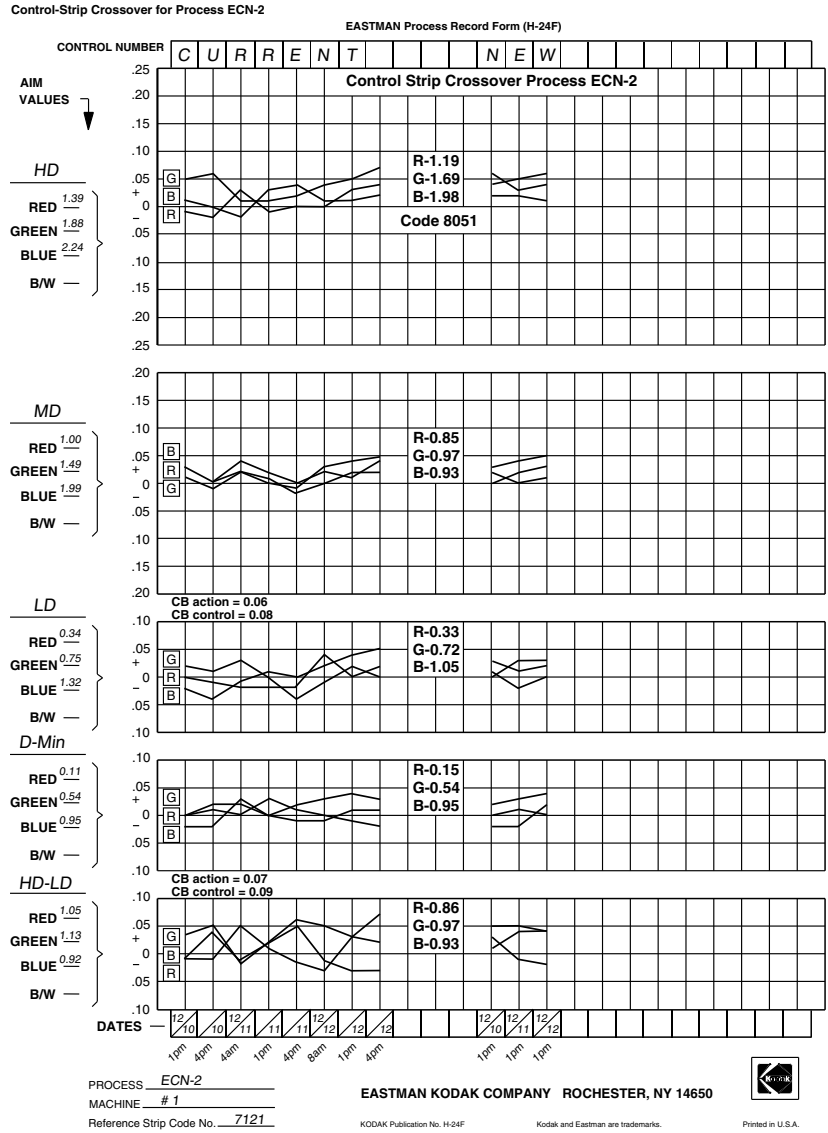
Changing to a New Batch of Control Strips

When you change from your current batch of control strips to strips with a different code number, make a crossover to confirm that both code numbers provide the same information. *Be sure that your process is stable and in control before you begin using a new batch of control strips.*

1. While you still have a week's supply of control strips of the current code, process one control strip from the new batch of strips with one strip from the current batch *in three separate runs*.
2. Read and record the densities of the processed strips.
3. Determine aim values for the new batch of control strips; see *Plotting Control-Strip Densities* on page 49.
4. For your current batch of control strips, calculate the variations from aim by subtracting your current aim densities from the densities of the three strips. Plot the variations on your control chart.
5. For the new batch of strips, calculate the variations from aim by subtracting the new aim densities (calculated in step 3) from the densities of the three strips. Plot the variations on your control chart.
6. Post the new aim values on the same form as the old, leaving an appropriate space between the two aim sets (as illustrated in the figure *Control Strip Crossover for Process ECN-2* on page 56). This way you can see the differences of each control strip reaction at a glance. Plot the differences from aim values for each batch on the same form. Both should be tracking in similar directions, but not exactly. However, they should still be within the same action and control limits. Please remember, no matter how the aim densities differ in numerical value, you still use each set as your zero (0) reference line.
7. Once you are comfortable with the new batch of control strips, use a new H-24F or Y-55 form to separate and not confuse the old and new aim numbers while making the daily notations.
8. If, for some reason, there is a need to adjust the process to conform the new batch of control strips to new action and control limits, cease processing, and evaluate the entire system. Such a need for change indicates a fundamental system difficulty, which most likely involves all aspects of the process, not necessarily a problem with the new batch of control strips. If difficulty continues, contact your Kodak representative.

Changing to a New Batch of Control Strips

Control Strip Crossover for Process ECN-2



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Troubleshooting Your Process

When one or more process parameters exceeds the control limits, stop processing customer work until you find and correct the cause of the problem. It is important to become familiar with control-chart patterns and cause-and-effect relationships. Control-chart patterns can generally be separated into three categories: high activity, low activity, and high D-min. Also, check your control chart to determine if the process drifted out of control slowly or suddenly.

High Activity—The process is out of control with process parameters plotting above aim. This condition can be caused by:

- Developer temperature that is too high
- Developer time that is too long
- Overreplenished developer (i.e., the solution is replenished at a rate that is too high)
- Mixing error
- Developer contamination
- Overconcentrated developer (from evaporation or insufficient topping off with water)

Low Activity—The process is out of control with process parameters plotting below aim. This condition can be caused by:

- Developer temperature that is too low
- Developer time that is too short
- Underreplenished developer (i.e., the solution is replenished at a rate that is too low)
- Mixing error
- Developer tank solution diluted with water
- Developer contamination

High D-min—This condition can be caused by:

- Developer oxidation caused by low utilization
- Developer contamination

Troubleshooting

Trend—An out-of-control condition that has occurred *slowly* over time indicates a problem such as:

Improper replenishment—caused by an incorrect replenishment rate, an incorrectly mixed replenisher, or a defective replenisher pump.

Evaporation or oxidation—caused by low utilization or air drawn into the processing solutions by a bad pump, a recirculation system leak, or a poorly placed ventilation fan.

Contamination—caused by photographically active materials that leach slowly into the solutions and cause the process to drift out of control. The contaminants may be in any material the solutions contact, such as the filters, plumbing, etc.

Incorrect mixing—if you suspect that the problem was caused by replenisher solution that was mixed incorrectly, mix a new batch of replenisher to see if a fresh mix gradually corrects the problem.

Sudden Change—An out-of-control condition that has occurs *suddenly* indicates a problem with your:

Control strip—check that you used control strips of the same code number. Remember, if you change code numbers, you need to establish new aim values for that code number (see *Changing to a New Batch of Control Strips* on page 55). Check that the control-strip code numbers match those of the reference strip. Check that the strips were handled and stored properly.

Densitometer—if your densitometer is not working properly or is out of calibration, the density readings will be wrong. This can falsely signal that there was a process change. Check that you used **Status M filters for Process ECN-2 and Status A filters for Process ECP-2E**.

Time or temperature—check that the time and temperature were set correctly, particularly if they are easy to change.

Contamination—bleach-fix splashed into the developer while cleaning racks or removing jams can cause sudden large spreads in your control plots.

Solution mixing—if the sudden change occurs after you have mixed a fresh tank solution, check that it was mixed correctly.

Aim values—check that you compared the control-strip densities with the correct aim values.

Note: When you troubleshoot a problem, check the easiest and most obvious causes first; then check the more difficult and less likely causes.

For complete information on diagnosing your process, see the control-chart examples in KODAK Publications No. H-24, *Processing KODAK Motion Picture Films*; H-326, *KODAK VISION Color Print Control Strips*, and *KODAK VISION2 Color Negative Control Strips*. This information is also available on the Kodak website at:

www.kodak.com/US/en/motion/support/processing.

APPENDIX

Film Handling

For information on Laboratory Aim Density (LAD), safelights, image structure, sensitometric curves, processing recommendations, film storage and types of rolls available, see the KODAK Publication relating to the film: H-1-film code i.e. 2393. Also refer to KODAK Publication No H-61, *LAD—Laboratory Aim Density*.

Film Storage and Handling

Store processed film at 21°C (70°F) or lower, and 40 to 50 percent relative humidity for normal or commercial use. For long-term storage conditions, see KODAK Publication No. H-845, *The Essential Reference Guide for Filmmakers*.

Exercise care when handling negative films to avoid scratches and/or dirt that will be noticeable on the final print. Have film handlers use lint-free nylon or DACRON gloves and handle the film the by edges. Further suggestions on how to keep camera or preprint films clean are in KODAK Publication No. H-24, Module 2, *Equipment and Procedures*.

Other Film Characteristics

For information on the physical characteristics of KODAK Motion Picture Films (including edge identification, antihalation backing, perforations, and dimensional change characteristics), as well as cores, spools, winding, and packaging, refer to KODAK Publication No. H-845, *The Essential Reference Guide for Filmmakers*.

Simplified Metric Conversion Charts

Simplified Metric Conversion Charts

Because most laboratory measuring devices are calibrated in metric units, you can use the following table to convert U.S. units of volume, length, and weight to metric units. **Do not** use this table to convert from metric to U.S. values.

Accuracy of the table is within one percent.

To use the table, find the number you are converting from at the top of the table for numbers from 1 to 9. For numbers greater than nine, find the number you are converting by using a combination of the number at the left side of the table and the number at the top.

Volume, Length, and Weight Conversion

U.S. Gallons to Litres										
gal	0	1	2	3	4	5	6	7	8	9
0	—	3.8	7.6	11.4	15.1	18.9	22.7	26.5	30.3	34.1
10	37.8	41.6	45.4	49.2	53	56.8	60.6	64.4	68.1	71.9
20	75.7	79.5	83.3	87.1	90.8	94.6	98.4	102.2	106	107.8
30	113.6	117.3	121.1	124.9	128.7	132.5	136.3	140.1	143.8	147.6
40	151.4	155.2	159	162.8	166.6	170.3	174.1	177.9	181.7	185.5
U.S. Fluid Ounces to Millilitres										
fl oz	0	1	2	3	4	5	6	7	8	9
0	—	29.5	59	89	118	148	177	207	237	265
10	295	325	355	385	415	445	475	500	530	560
20	590	620	650	680	710	740	770	800	830	860
30	890	920	950	980	1006	1035	1065	1094	1124	1153
Inches to Centimetres										
in.	0	1	2	3	4	5	6	7	8	9
0	—	2.5	5.1	7.6	10.2	12.7	15.2	17.8	20.3	22.9
10	25.5	28.0	30.5	33.0	35.5	38.0	40.5	43.0	45.5	48.5
20	51	53	56	58	61	64	66	69	71	74
30	76	79	81	84	86	89	91	94	97	99
Ounces to Grams										
oz	0	1	2	3	4	5	6	7	8	9
0	—	28.5	57	85	113	142	170	198	227	255
10	285	310	340	370	395	425	455	480	510	540
20	570	600	620	650	680	710	740	770	790	820
30	850	880	910	940	960	990	1021	1049	1077	1106

You can use the following to convert from metric to U.S. values or from U.S. to metric values. To do this, multiply the metric or U.S. units in column 1 by the

Simplified Metric Conversion Charts

number in column 2 (e.g., to convert 450 millilitres to fluid ounces, multiply 450 by .03382 = 15.22 fluid ounces).

Conversion Factors

To Convert	Multiply By
Millilitres to Fluid Ounces	.03382
Fluid Ounces to Millilitres	29.573
Pints to Litres	.4732
Litres to Pints	2.113
Quarts to Litres	.9463
Litres to Quarts	1.057
Gallons to Litres	3.785
Litres to Gallons	.2642

Temperature Conversion

Temperature Conversion

To convert a temperature from one unit of measure to another, use the following table. Find the temperature you are converting from in the °F or °C column; if you are converting to degrees Celsius, read the number from the to °C column. If you are converting to degrees Fahrenheit, read the number from the to °F column.

to °C	°F or °C	to °F	to °C	°F or °C	to °F	to °C	°F or °C	to °F
37.78	100	212.0	18.33	65	149.0	-1.11	30	86.0
37.22	99	210.2	17.78	64	147.2	-1.67	29	84.2
36.67	98	208.4	17.22	63	145.4	-2.22	28	82.4
36.11	97	206.6	16.67	62	143.6	-2.78	27	80.6
35.56	96	204.8	16.11	61	141.8	-3.33	26	78.8
35.00	95	203.0	15.56	60	140.0	-3.89	25	77.0
34.44	94	201.2	15.00	59	138.2	-4.44	24	75.2
33.89	93	199.4	14.44	58	136.4	-5.00	23	73.4
33.33	92	197.6	13.89	57	134.6	-5.56	22	71.6
32.78	91	195.8	13.33	56	132.8	-6.11	21	69.8
32.22	90	194.0	12.78	55	131.0	-6.67	20	68.0
31.67	89	192.2	12.22	54	129.2	-7.22	19	66.2
31.11	88	190.4	11.67	53	127.4	-7.78	18	64.4
30.56	87	188.6	11.11	52	125.6	-8.33	17	62.6
30.00	86	186.8	10.56	51	123.8	-8.89	16	60.8
29.44	85	185.0	10.00	50	122.0	-9.44	15	59.0
28.89	84	183.2	9.44	49	120.2	-10.00	14	57.2
28.33	83	181.4	8.89	48	118.4	-10.56	13	55.4
27.78	82	179.6	8.33	47	116.6	-11.11	12	53.6
27.22	81	177.8	7.78	46	114.8	-11.67	11	51.8
26.67	80	176.0	7.22	45	113.0	-12.22	10	50.0
26.11	79	174.2	6.67	44	111.2	-12.78	9	48.2
25.56	78	172.4	6.11	43	109.4	-13.33	8	46.4
25.00	77	170.6	5.56	42	107.6	-13.89	7	44.6
24.44	76	168.8	5.00	41	105.8	-14.44	6	42.8
23.89	75	167.0	4.44	40	104.0	-15.00	5	41.0
23.33	74	165.2	3.89	39	102.2	-15.56	4	39.2
22.78	73	163.4	3.33	38	100.4	-16.11	3	37.4
22.22	72	161.6	2.78	37	98.6	-16.67	2	35.6
21.67	71	159.8	2.22	36	96.8	-17.22	1	33.8
21.11	70	158.0	1.67	35	95.0	-17.78	0	32.0
20.56	69	156.2	1.11	34	93.2	-18.33	-1	30.2
20.00	68	154.4	0.56	33	91.4	-18.89	-2	28.4
19.44	67	152.6	0.00	32	89.6	-19.44	-3	26.6
18.89	66	150.8	-0.56	31	87.8	-20.00	-4	24.8

Temperature Conversion

For temperatures not shown in the table on page 60, use the following formulas:

1. To convert Fahrenheit to degree Celsius, subtract 32 from the Fahrenheit temperature. Then divide the result by 1.8.

$$C = (F - 32) \div 1.8$$

2. To convert Celsius to degrees Fahrenheit, multiply the Celsius temperature by 1.8. Then add 32 to the result.

$$F = (C * 1.8) + 32$$

Analytical Procedures

Analytical Procedures Spectrophotometric Determination of Iodide in Fixer ECP-2-936A

PRINCIPLE

The iodide is oxidized to iodine by sodium nitrite and then extracted into chloroform. The chloroform phase is dried with sodium sulfate and its absorbance measured at 508 nm. Hydrogen peroxide is used to oxidize the thiosulfate present so that the nitrite will be available to oxidize the iodide. A pretreatment with zinc is necessary on seasoned solutions containing silver. Silver salts are reduced to metallic silver, minimizing the possibility of silver reacting iodide.

Methanol interferes with the analysis by decreasing the absorbance of the iodine solution. The chloroform is washed to remove the stabilizing alcohol in it, and care must be taken to remove methanol from “dried” cells by rinsing with washed chloroform. This procedure applies only for iodide determination in Process ECP-2E Fixer F-35b.

This method requires handling potentially hazardous chemicals. Consult the Material Safety Data Sheet for each chemical before use. MSDS's are available from your chemical supplier.

RELIABILITY

Five replenisher formula calibration mixes were prepared with potassium iodide concentrations ranging from 0.10 to 0.30 g/L. Three analysts in two laboratories using two types of spectrophotometers analyzed each of the five mixes in duplicate. Sixteen data points were used to derive an equation and predict 95 percent confidence limits for an individual analysis of ± 0.02 g/L KI.

SPECIAL APPARATUS

- Exhaust Hood
- Spectrophotometer with tungsten lamp
- 1-cm Silica Cell
- Whatman 2V Filter Paper, folded, 12.5 cm

Note: Use pipets and volumetric glassware meeting the “Class A” definition by the National Institute of Standards and Technology (NIST).

REAGENTS

Use ACS Reagent Grade reagents unless specified otherwise.

- Sodium Bromide, NaBr
- 5 M Sodium Nitrite, NaNO₂
- 2 M Citrate Buffer, pH 3.92
- Sodium Sulfate, Na₂SO₄
- Chloroform, CHCl₃, Spectro-grade, Washed
- Methanol, CH₃OH, Spectro-grade
- 30 percent Hydrogen Peroxide, H₂O₂
- Zinc (10 to 30 mesh)

PROCEDURE

Glassware Preparation

1. Rinse the following with distilled water; a 125-mL separatory funnel, a 125-mL conical flask, and a powder funnel. Drain well, but do not dry them with methanol.

Note: Follow locally acceptable procedures for disposal of chloroform.

2. Dry a clean silica cell with methanol, then rinse it twice with washed chloroform and drain.

Sample Pretreatment

(Omit this step for fresh tank and replenisher.)

Note: This pretreatment step is necessary for seasoned solutions containing silver.

1. Weigh 1.0 g of zinc (10 to 30 mesh) into a 150-mL beaker.
2. From a graduated cylinder add 50 mL of sample to the beaker and stir for 1 minute.
3. Filter the solution through a Whatman 2V filter paper into a 125-mL conical flask.

Iodide Oxidation



Caution

Nitrous oxide (a product of nitrite-iodide reactions) and chloroform are toxic. The extractions must be performed in an exhaust hood where there is adequate ventilation.

1. Weigh 5.0 g of sodium bromide and set aside.

Analytical Procedures

2. Pipet (wipe before leveling) 10 mL of sample into the previously prepared 125-mL separatory funnel.
3. Add 1 mL of hydrogen peroxide (30 percent), from a tip-up pipet, to the separatory funnel.
4. Add 10 mL of 5 M sodium nitrite, from a tip-up pipet, to the separatory funnel.
5. Add, using a powder funnel, the previously weighed sodium bromide to the separatory funnel. Stopper and shake vigorously until the sodium bromide is dissolved, usually 10 to 15 seconds, venting after 2 or 3 seconds.
6. Add 50 mL of 2 M citrate buffer, from a tip-up pipet, to the separatory funnel; swirl to mix.
7. Set a timer for 15 minutes. Stopper and shake vigorously for 2 to 3 seconds and again after 5, 8, and 12 minutes. Remove the stopper between shakes.
8. During the 15-minute period, add approximately 5 g of anhydrous sodium sulfate to a prepared 125-mL conical flask equipped with a glass stopper. (One level scoop from a No. 05 Coors porcelain spoon is approximately 5 g.)

Iodine Extraction

1. After the timer sounds, add 10 mL of washed chloroform, from a tip-up pipet, to the separatory funnel.
2. Stopper the funnel and shake for 30 seconds, venting after 2 to 3 seconds.
3. Allow the phases to separate for 1 minute and drain the chloroform (lower) layer into the 125-mL flask containing the sodium sulfate. Do not attempt to remove all of the chloroform; allow a few drops of the chloroform to remain in the funnel to ensure that no water is drained into the flask.
4. Perform a second extraction by immediately repeating steps 1 through 3, adding chloroform to the same 125-mL flask.
5. Stopper and shake the 125-mL conical flask for 10 seconds.
6. Set a timer for 1 minute.

Absorbance Measurement

1. Immediately after the timer sounds, decant some of the chloroform solution into a prepared 1-cm silica cell, rinsing twice with the chloroform solution and then filling.
2. Measure the absorbance of the sample at 508 nm, using a tungsten lamp (A_{508}).

Note: If the absorbance reading decreases rapidly, repeat the analysis, using more care in keeping water and/or methanol from the chloroform in the flask and cell. If the chloroform solution turns to a peach or orange color before the reading is taken, repeat the analysis after checking the buffer to see if it is within its pH limits.

Calculation

$$\text{KI, g/L} = 0.951(A_{508}) + 0.003$$

Determination of Total Iron in EASTMAN Color Films, Process ECN-2 "UL" Type Bleach Using a HACH Pocket Colorimeter Test Kit ECN-0026-01

This test kit (HACH catalog no. 46700-22) is used to determine total iron in EASTMAN Color Films, Process ECN-2, "UL" type bleach samples. The bleach samples are diluted and mixed with a FerroVer® Iron Reagent Powder Pillow to create a colored solution. This colored solution is measured using the HACH Pocket Colorimeter provided with the test kit. The absorbance is then used to calculate the amount of iron in the bleach.

"Determination of Total Iron in EASTMAN Color Films, Process ECN-2, UL Type Bleach Using HACH Colorimeter Test Kit" (*ECN-2-UL-3280*) is used with the previous analog colorimeter Model DR 100.

Use of this method requires handling of potentially hazardous chemicals. Material Safety Data Sheets (MSDS) should be consulted for each chemical before use. These can be obtained from each chemical supplier.

PRECISION AND BIAS

Repeatability Standard Deviation ($1s_r$) & 95 Percent Confidence Estimate (not including bias)

Repeatability standard deviation is an estimate of the variability one trained analyst should be able to obtain under favorable conditions (analyzing a sample, with one instrument, within one day).

The 95 percent confidence estimate (calculated using the repeatability standard deviation) around a single test will include the mean value 95 percent of the time.

Analytical Procedures

To obtain the repeatability data, a single skilled analyst performed five (5) replicates on each of the following solutions during methods development.

1. A “fresh” UL type bleach tank prepared with all components at their respective “working tank” aim concentrations.
2. A “seasoned” UL type bleach tank analyzed colorimetrically as received, at 5.59 g/L iron.
3. The same “seasoned” solution as in number 2, above, reanalyzed after making an analytically weighed, standard addition of 1.68 g/L iron.

Iron				
Sample	Mean (g/L Iron)	N	Repeatability Standard Deviation, 1S _r (g/L Iron)	95 Percent Confidence Estimate (g/L Iron)
“Fresh” (Prepared at 4.94 g/L)	5.04	5	0.065	±0.18
“Seasoned” As Received	5.59	5	0.022	±0.06
“Seasoned” plus Standard Addition	7.06	5	0.065	±0.18

Bias

Bias is a statistically significant deviation of the mean from the known mix level at a 95 percent confidence level. It is determined for fresh samples only. Bias is not determined for seasoned samples, since the component concentration level is not determined independently of the test method.

A bias of 0.10 g/L iron was found to be statistically significant at the 95 percent confidence level, but was judged not to be practically significant.

Recovery

Recovery is used for seasoned samples, since the component concentration level is not determined independently of the test method. It is defined as the calculated mean for the seasoned sample with a standard addition of the component minus the mean for the seasoned sample, divided by the actual amount of the standard addition. It is expressed as a percentage.

Statistically, the recovery of 87.50 percent was statistically different from 100 percent at the 95 percent confidence level, but was judged not to be practically significant.

Reproducibility

Customer Standard Deviation, $1s_c$ & 95 Percent Confidence Estimate (not including bias)

Reproducibility or customer standard deviation ($1s_c$) is an estimate of the variability a customer could expect when submitting a sample to any Photoprocessing Quality Services laboratory, where any trained analyst could test the sample using any instrument on any day.

The 95 percent confidence estimate (calculated using the customer standard deviation) around a single test result will include the mean value 95 percent of the time.

Because the results of the repeatability study show similar variability to the method *ECN-2-UL-3280* that used an analog model colorimeter, and the reagent chemistry is unchanged, it is expected that the newer instrument with digital readout will exhibit comparable or superior performance under reproducibility conditions. Therefore, a reproducibility study was not performed. The results of the previous method reliability are duplicated below as a reference.

Three fresh mixes of Process ECN-2, "UL" Bleach (5.0, 10.0, 15.0 g/L total iron) were analyzed in duplicate on one day by three skilled analysts. A pooled standard deviation ($1s$) of 0.70 g/L ($n=16$) was calculated. The 95 percent confidence estimate, based on the pooled standard deviation, was ± 1.94 g/L. High biases of 18.8 percent, 9.4 percent, and 9.6 percent were found at the low, aim, and high levels, respectively.

A seasoned bleach sample analyzed to be 5.00 g/L total iron, and a standard addition to that sample of 1.06 g/L iron were analyzed in the same manner as the fresh samples. For the seasoned samples, the standard deviation ($1s$) was 0.089 g/L ($n=6$) and the 95 percent confidence estimate was ± 0.23 g/L. Recovery of the standard addition was 95 percent.

APPARATUS

All volumetric glassware should meet all "Class A" specifications, as defined by American Society for Testing and Materials (ASTM) Standards E 287, E 288, and E 969, unless otherwise stated.

- 100, 500 mL volumetric flasks
- 2.0, 5.0 mL pipets
- Included in HACH test kit:
 - (2) 2.5 cm sample cell
 - HACH Pocket Colorimeter

REAGENTS

Use ACS Reagent Grade reagents unless otherwise specified.

Analytical Procedures

- FerroVer® Iron Reagent Powder Pillow
- Water, Type I Reagent – This method was developed using reagent water equivalent to purer than Type I Grade, as defined in ASTM Standard D 1193. Other grades of water, e.g., reverse osmosis (RO), demineralized, or distilled water, may give equivalent results, but the effects of water quality on method performance have not been studied.

PROCEDURE

Refer to the Pocket Colorimeter Analysis System Instruction Manual for additional information including safety precautions, a general description, and calibration routines for Hi and Lo range samples.

1. Pipet 5.0 mL of bleach sample into a 500 mL volumetric flask. Dilute to volume with reagent water. Invert six times to mix.
2. Pipet 2.0 mL of the solution contained in the 500 mL volumetric flask (prepared in step 1) into a 100 mL volumetric flask. Dilute to volume with reagent water. Invert six times to mix
3. Rinse both the 2.5 cm sample cells using the solution prepared in step 2. One cell will be used for sample reagent and the other as a blank.
4. Fill one of the sample cells to the 10 mL mark (white line) with the solution prepared in step 2. This will be sample reagent one.
5. Tear open one of the FerroVer Iron Reagent Powder Pillows and add its contents to the sample cell from step 4. Cap the cell and shake to mix. Wipe the outside of the cell with a clean tissue. (An orange color will develop if iron is present.)

Note: After preparation of the sample in step 5, the remaining steps of this procedure must be performed within 30 minutes.

Note: Accuracy is not effected by undissolved powder.

6. Set and start a timer for three minutes.
7. After three minutes have elapsed, fill the second 2.5 cm sample cell from step 3 to the 10 mL mark (white line) with the solution from step 2. This will be blank one.
8. Cap the blank sample cell. Wipe the outside of the cell with a clean tissue. This cell is used as a sample blank to zero the instrument. No FerroVer reagent is added.
9. Remove the instrument cap from the Pocket Colorimeter.
10. Place the blank sample cell from step 8 into the cell holder with the diamond mark facing the keypad.

Analytical Procedures

11. Tightly cover the blank sample cell with the instrument cap (flat side facing the back of the instrument).
12. Press 'ZERO'. The instrument will display "---" followed by "0.00".
13. Within 30 minutes after the 3 minute waiting period, place the reagent sample cell prepared in step 5 into the cell holder with the diamond mark facing the keypad.
14. Tightly cover the reagent sample cell with the instrument cap (flat side facing the back of the instrument).
15. Press 'READ'. The instrument will display "---" followed by the results in mg/L iron.

CALCULATIONS

Multiply the mg/L iron reading (obtained in step 15, above) by 5 to obtain the iron content of the sample in g/L:

$$\text{g/L iron} = (\text{reading in mg/L iron from step 15}) \times \frac{5000 \text{ fold dilution}}{1000 \text{ mg/g}}$$

$$\text{g/L iron} = (\text{reading in mg/L iron from step 15}) (5)$$

Example:

$$\text{g/L iron} = (0.89 \text{ mg/L}) (5)$$

$$\text{g/L iron} = 4.45 \text{ g/L}$$

Analytical Procedures

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