



Using KODAK B&W Reversal Chemicals in Motion Picture Film Laboratories

This publication is for laboratory operators. It provides the most used technical information about film processes when using KODAK B&W Reversal Kit Chemicals in motion picture laboratories.

Using KODAK B&W Reversal Kit Chemicals will help you provide optimum results with the least possible environmental impact.

This publication describes the processing cycles recommended for processing KODAK Motion Picture B&W Reversal Films.

This manual has four sections:

- Chemicals and Chemical Handling
- KODAK B&W Reversal Kit Chemicals
- Process Monitoring
- 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 the right choice of chemicals, properly handled. Proper chemical handling includes adherence to storage and mixing guidelines, and strict 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 B&W Reversal Kit Chemicals
- 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

The following definitions are provided to help you understand the chemical terms used in this manual.

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.”

Process Sequence

The following table contains a general description of what happens during the processing steps of typical black-and-white reversal motion picture films.

Step	What Happens
First Developer	Develops camera-exposed light-sensitive silver halide crystals to metallic silver (a negative image). Time and temperature control are critical for optimum results.
Wash	Removes first developer from the film.
Bleach	Dissolves the metallic-silver negative image produced in the first developer but does not affect the remaining silver halide.
Wash	Removes excess bleach from the film.
Clearing Bath	Removes any bleach left from the wash step and prepares the film for redevelopment.
Re-exposure	Exposes the silver halide crystals that were not exposed in the camera.
Second Developer	Develops remaining exposed silver halide to produce a positive image.
Wash	Removes second developer.
Fixer	Removes any undeveloped silver halide grains. This step should yield minimal silver.
Wash	Removes fixer from the film.
Dryer	Dries the film in preparation for printing or projection.

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.

First Developer—The developer chemically reduces the exposed silver halide in the film to form a metallic silver image (negative image). The amount of this development determines the overall density of the image, and so the actual photographic speed of the films.

The required development time, which should be sufficient to give clean highlights with normal camera exposures, could vary with different processors and will need to be determined by practical tests.

While some control of maximum density, minimum density, and contrast can be exercised in other steps of the process, the effect of excessive or insufficient first development cannot be fully compensated for in the later steps, and a loss of quality is almost inevitable.

Wash—A water wash is necessary to prevent the carry-over of first developer into the bleaching solution.

Bleach—The bleach dissolves the metallic-silver negative image that is produced in the first developer but does not affect the remaining undeveloped silver halide.

Occasionally, the bleach can cause heavy density and streakiness to appear in the picture after the second developer. This may result from insufficient agitation, improper mixing, or from an increase in pH of the bleach due to use of the bleach solution beyond its capacity.

Too much bleach time can result in a reduced sensitivity to re-exposure, causing a selective loss in lower mid-tone densities and consequent excessive contrast. A high level of agitation is important in the bleach.

The bleach is an acidic oxidizing solution that will rapidly attack most metals. Therefore, any metal parts of the equipment that will come into contact with the bleach solution should be made of corrosion-resistant material, such as Type 316 stainless steel, titanium, Hastelloy C, or various plastics (excluding polypropylene, which reacts with the permanganate bleach). Please refer to page 22 for recommendations of the materials to use for the bleach tank system.

Wash—Removes any excess bleach left on the film.

Clearing Bath—Treatment in the clearing bath removes any bleach left after rinsing and prepares the residual silver salts for the subsequent steps. A stronger than recommended clearing bath or a long immersion time will often cause a loss in density. Short times in the clearing bath can lead to stains.

Re-exposure—The re-exposure should be sufficient to render the residual silver salts fully developable. Optimum re-exposure is about 8600 Lux-sec (800 fcs). This will be provided by a 10-second exposure to a 60-watt lamp at 12 to 18 inches (31 to 46 cm).

The amount of re-exposure is not critical. However, excessive exposure (in the order of 10 times) may cause a slight and undesirable increase in density, which will be most noticeable in the highlight areas of the projected image. Too little re-exposure (in the order of 1/100 of the optimum) tends to reduce the maximum density objectionably. Re-exposure levels should be checked by trial to ascertain that no noticeable change in picture quality accompanies a two- to five-times change in re-exposure in either direction.

Re-exposure can be applied at any point from the latter part of the clearing treatment to the early part of the second developer. If re-exposure is given in the clearing bath, no additional contact with that bath should be required; if given while the film is in the second developer, sufficient time must be allowed subsequently for the developer to complete its work.

Re-developer—This second developer now reduces the just re-exposed silver halide remaining in the emulsion to a positive silver image.

Wash—Removes any excess re-developer left on the film.

Fixer—Redevelopment leaves a small proportion of silver halide grains undeveloped. And there may be silver salts or other hypo-soluble compounds deposited on the film, which will darken and discolor the highlights after the film has been stored and exposed to light. One of the functions of the fixing bath is to dissolve these residues, causing a reduction in minimum density and an improvement in overall brilliance and highlight quality.

Wash—Removes any excess re-developer left on the film.

Dryer—dries the film in preparation for projection.

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 mainly supplied in liquid concentrates for easy mixing and handling, and they are available in convenient and economical sizes. Some, such as the permanganate bleach, have powder constituents that need to be dissolved when mixed.

Features and Benefits for Kit Chemical Processes

Features	Advantages	Benefits
Complete Packaged Kit	• Easy to use • No technical lab staff needed • Avoids mixing errors • Saves time – no measuring out of chemicals • Saves effort – just add water	• Potential labor savings due to reduced chemical analysis, reduced measuring and re-mixing due to errors • Better productivity
Made by Kodak	• Consistent chemical strength of solution • Mixes to correct aims • Meets current environmental standards • Consistency from mix to mix	• Higher quality process produces higher quality results • Little chemical analysis needed for standard production • More satisfied customers
All-liquid (except for bleach)	• Fewer chemical powders being used	• Less dust for chemical mixers
Supplied by Kodak	• Only need to order from one supplier	• Reduced ordering/admin costs
Stocked by Kodak	• Order as needed, not in bulk	• Reduced inventory carrying costs
Supported by Kodak	• Full Kodak technical support for problem resolution	• Reduced lab downtime • Easy to get help

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. Outside the U.S. and Canada, please contact the Kodak representative 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 (MSDSs) for more handling information. Material Safety Data Sheets are available at the Entertainment Imaging Internet site, 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 MSDSs. 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 Internet site at www.kodak.com/go/motion.

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. Get medical attention if symptoms persist. 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 liters/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

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—Keep processing and mixing equipment and storage containers clean to minimize the possibility of contamination. 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
- improperly maintained processor solution crossover devices

How to Check Your Chemicals

Fresh KODAK B&W Reversal Kit Chemical 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. See page 17 for more information.

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.
- Use floating lids on all solutions to reduce oxidation and evaporation.
- **Do not store bleach in metal containers. Avoid prolonged contact of bleach with metal or hard rubber processing equipment.**

For best results, **do not** use KODAK B&W Reversal Kit Chemicals stored longer than the times given in the table below:

Mixed Solutions	Deep Tank with Close-fitting Floating Cover	Open Deep-tank
First Developer Starter	2 weeks	3 days
First Developer Replenisher	2 weeks	3 days
Bleach and Replenisher ^a		
Clearing Bath	1 month	3 weeks
Redeveloper and Replenisher	2 weeks	3 days
Rapid Fixer	1 month	3 weeks

^a For best results, mix the bleach solution just prior to use, although it can be mixed for up to two weeks before use.

Compensating for Evaporation

When water evaporates from processing solutions, the chemical components remain, and the solutions become over-concentrated. Evaporation occurs to some degree naturally, but 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.

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—over-dilution of the tank solution may occur.

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—over-dilution of the tank solution may occur.

When using this technique, it is important not to disturb solids, which can drop back into the solution as solid particles. This technique will only work if there is minor evaporation, and you are re-dissolving 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—over-dilution of the tank solution may occur. To minimize chemical buildup, clean and rinse crossovers thoroughly using only small amounts of water.

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.

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 photo processing 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 liter 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. Flush tanks with water **thoroughly** before refilling 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 in the U.S. and Canada, contact the Kodak Information Center at (800) 242-2424. Outside the U.S. and Canada, contact your Kodak representative. For information on controlling biological growth, request a copy of KODAK Publication CIS-3, *Biocides for Photographic Solution Tanks and Wash Water*.

Disposing of Processing Effluent to a Publicly Owned Treatment Works (POTW)

Managing processing effluent is an important operation in your lab. Where regulations permit, Kodak recommends discharging process effluents to an efficiently operated secondary biological treatment plant often referred to as a publicly owned treatment works (POTW). Effluent from processing KODAK D-94A Kit Chemicals consists of first and second developer, de-silvered bleach, de-silvered fixer, clearing bath, and wash water. Because regulations define photographic effluent as an industrial waste discharge, you will likely need a permit from a local authority to discharge to a treatment works via a public sewer system. The permit will define acceptable levels of regulated effluent parameters. Each country has its own regulations regarding disposal of processing effluents. Local variations within a country are also common.

Many factors affect effluent parameters, including mode of operation (batch vs. replenished), replenishment and wash rates, type of processor, chemical regeneration, and treatment methods. After efficient silver recovery, the combined effluent from a lab using KODAK D-94A Kit Chemicals and standard process operating conditions will be light amber or straw-colored. For more information on the composition of photographic solutions that you use, see the Material Safety Data Sheets (MSDSs). MSDS sheets are available at the Kodak Internet site, www.kodak.com/go/hse. If you need additional help in the U. S. and Canada, call the Kodak Information Center at (800)-242-2424. In other regions, contact a Kodak representative in your country.

Disposal of Chemical Concentrates

Unlike normal process effluents, which are generally governed by local sewer use codes, waste chemical concentrates may be covered by Hazardous Waste and/or Hazardous Material Transportation Regulations. For more information, refer to the *Disposal Considerations and Transport Information* sections of the Safety Data Sheet (SDS) for each concentrate. Hazardous waste and hazardous materials transportation regulations vary by location and size of operation. Consult with local authorities for your specific requirements. For additional information, consult the KODAK Publication No. H-24, [Processing KODAK Motion Picture Films, Module 6: Environmental Aspects](#), or Kodak Publication No. J-411, *Dealing with Hazardous Waste & Photographic Processing Effluents*.

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 standard replenishment rates and check them often
- use effective solution crossover devices
- avoid making batch discharges, such as tank dumps
- de-silver bleach and fixer before you discharge it

Other Effluent Disposal Methods

Haul-away—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.

Direct Discharge—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—Septic systems are designed for sanitary, rather than industrial wastewater. 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.

More information

For additional information, consult the KODAK Publication No. H-24, *Processing Manual, Module 6: Environmental Aspects*, www.kodak.com/US/en/motion/support/processing/h246

Silver Recovery

Silver is a seasoning product of processing photographic films. Sewer codes may limit the concentration of silver that may be discharged in effluent. To reduce the amount of silver in the effluent, you can de-silver used reversal bleach and fixer solutions. The following sections describe how silver may be removed from each of the above solutions.

Reversal Bleach: Silver Recovery & pH Neutralization

Silver Recovery—Unlike traditional photographic bleaches, the B/W reversal bleach is very acidic and it contains significant silver. Always wear appropriate Personal Protective Equipment (PPE) when handling the bleach. It should be treated to remove silver before discharging to the sewer. Traditional de-silvering methods, such as electrolytic silver recovery, are not effective and should not be used. The silver recovery method of choice is batch precipitation using sodium chloride, or common table salt. This recovery technique does not work for fixer solutions.

Salt can be added either in solid form or dissolved in water. Add 4 grams of salt for every gram of silver in the bleach. After a few minutes of slow, steady mixing, a white precipitate will form. The precipitate will settle well with time. After settling for a few hours the supernatant can be poured or pumped off.

Another alternative is to filter the slurry through filter cloth or paper.

Note: *Just about any filter material will work. However, the corrosive bleach attacks many filter materials. Therefore, filter material should not be reused.*

The solid can be collected in a container for shipment to a refiner, or it can be dissolved in excess reversal fixer. Once it is dissolved in the fixer, traditional silver recovery techniques can be used. Fixer containing dissolved silver from reversal bleach should not be recycled or reconstituted for use in the process. This fixer should go to terminal silver recovery, then to the drain.

pH Neutralization—Because the bleach is very acidic, it should be combined with the other processing solutions or brought to a neutral pH with a basic solution before being discharged to the drain (environmental restrictions may apply—check with your local authorities). The developer and clearing bath overflows work well for neutralization, although some suspended solids are produced in this process. If there are strict sewer codes for suspended solids, the use of developers is not recommended. Carbonates are not recommended for neutralization as they cause misting, and can result in droplets of bleach on the surrounding surfaces. During neutralization, the bleach will lose its bright purple color.

Fixer Solutions: Silver Recovery

You can de-silver used reversal fixer solutions with an electrolytic silver-recovery cell and/or silver-recovery cartridges (metallic replacement). Electrolytic silver recovery is most effective for fixer with silver levels greater than 0.5 g/L. If the silver concentration in your fixer does not normally exceed this level (and you will not be using the fixer to re-dissolve silver precipitated from the reversal bleach) metallic replacement cartridges are the most practical means of removing silver.

Metallic Replacement Cartridges—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
- the simplicity of installation

The disadvantages, compared to the electrolytic method, are:

- the silver is recovered as a sludge, making it more difficult to determine the exact amount recovered
- the sludge requires more refining than the plate silver obtained from electrolytic methods

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. Discharge the de-silvered effluent with the other processing solutions.

Electrolytic Silver Recovery—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.

Operate your electrolytic-recovery cell according to the manufacturer's instructions. Because there may be 0.5 to 1.0 g/L of silver remaining in solution following electrolytic silver recovery, metallic replacement is often used to remove the remaining silver. 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 the other processing solutions in accordance with local sewer regulations.

More information

For additional information, refer to KODAK Publication No J-215, *Recovering Silver from Photographic Processing Solutions*.

KODAK B&W REVERSAL KIT CHEMICALS

This section includes:

- List of chemicals used for KODAK B&W Reversal Kit Chemicals
- Characteristics of KODAK B&W Reversal Kit Chemicals
- Processing cycles for KODAK B&W Reversal Kit Chemicals
- General Notes
- Mixing Instructions for KODAK B&W Reversal Kit Chemicals
- Conversion from dichromate bleach to permanganate bleach
- pH Adjustment

List of Chemicals for KODAK B&W Reversal Kit Chemicals

KODAK B&W Reversal First Developer Starter	Minimum order quantity consists of one, 1-quart bottle. Each bottle can season a 16-gallon batch of first developer tank solution. Mix 4 gallons of first developer replenisher plus one quart of first developer starter and adjust with water to 16 gallons. CAT No. 7504723
KODAK B&W Reversal First Developer Replenisher	Minimum order quantity is one 5-gallon HDPE plastic pail. Add water to yield 15 gallons of first developer replenisher. CAT No. 7453301
KODAK Reversal Redeveloper and Replenisher	Minimum order quantity is one 5-gallon HDPE plastic pail. Add water to yield 15 gallons of redeveloper replenisher. CAT No. 7434715
KODAK B&W Reversal Bleach and Replenisher Parts A and B	Minimum order quantity is one case. One case consists of two bottles of Part A and two bottles of Part B. Mix one bottle of Part A and one bottle of Part B with two bottles of Part C to make 20 gallons of bleach replenisher. CAT No. 8080913
KODAK B&W Reversal Bleach and Replenisher Part C	Minimum order quantity is one case. Each case consists of four plastic bottles of Part C. Mix two bottles of Part C with one bottle of Part A and one bottle of Part B to make 20 gallons of bleach replenisher. CAT No. 1891886
KODAK Reversal Clearing Bath and Replenisher	Minimum order quantity consists of one 5-gallon HDPE plastic pail. Each flexible container will yield 15 gallons of reversal clearing bath. CAT No. 7434707
KODAK Rapid Fixer Solution	Minimum order quantity consists of 2 units (1 case). Each unit consists of one 5-quart bottle of Part A and one 18-ounce bottle of Part B. Each unit yields 5 gallons of fixer solution. CAT No. 7506504

Characteristics of B&W Reversal Kit Chemicals

Chemical	Part	Normal Appearance	Comments
First Developer First Developer Replenisher		Clear, yellow amber solution, odorless	A precipitate may appear in developers that are kept too long (more than 2 years) and/or exposed to cold temperature. If color and odor are normal, the developer is usable if the precipitate dissolves upon mixing.
First Developer Starter		Clear, colorless solution, odorless	
Bleach	A	White, granular, free flowing powder	Calgon S is infinitely soluble,
	B	Dark purple, granular, free flowing powder	
Bleach Replenisher	C	Clear, colorless solution, odorless	
Clearing Bath		Clear, colorless solution, odorless	Occasionally you may see a very small amount of light yellow-brown sediment in the mix. This material should not affect processing.
Redeveloper Redeveloper Replenisher		Clear yellow liquid, odorless	
Fixer	A	Clear light yellow solution, slight sulfur dioxide & acetic acid odor	
Fixer Replenisher	B	Clear water-white solution, slight sulfur dioxide odor	

Processing Cycles

There are many different types of processors, and they are used under a variety of conditions. KODAK chemicals are designed to help your lab achieve the best results.

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 B&W Reversal Films. Use the rates as starting points; adjust them as required according to your control-plot results.

Processing Specifications

Use the processing times and drying conditions shown in the following table as a guide for preliminary machine design. Actual processing times may differ from the ones shown in the table because of machine-design variables such as film-transport speed, degree of solution agitation, amount of solution carry-over, etc. Use the listed temperatures and times as a starting point to determine the specifications necessary to produce quality films in your installation. Optimum drying conditions (air volume, temperature, and relative humidity) will also vary with each dryer design. Use the replenishment rates indicated in the table as a starting point for chemical-analytical specifications.

Processing Specifications for Reversal Film

Process Steps	Time 24.4°C (76°F)	Replenishment per 100 ft (30.5 m) of 16 mm film ^a		Recirculation (R) Agitation (A) Filtration (F)
		Film	Leader	
First Developer	60 sec	187 mL	45 mL	R, A, F
Wash ^b	30 sec			
Bleach	60 sec	145 mL	100 mL	Vigorous A
Wash	30 sec			
Clearing Bath	30 sec	195 mL	75 mL	A
Wash	30 sec			
Re-exposure	800 footcandle seconds / 8600 Lux-sec.			
Second Developer	30 sec	75 mL	45 mL	R, A
Wash	30 sec			
Fixer	30 sec	100 mL	45 mL	R, A
Wash ^c	2 min			

^a Use these replenishment rates as starting points. Determine actual rates by chemical analysis after processing a significant amount of film.

^b A stop bath must not be used in place of the wash.

^c The efficiency of the water application and the permissible residual hypo concentration for the intended use determine the actual wash time. ANSI PH 4.8-1985 is a worldwide standard for determining residual hypo. The ANSI recommendation for extended life expectancy storage is .2-.4 µg/cm²

General Notes

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

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, and 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; the temperature may be reduced or the relative humidity may be increased.

Correct drying of photographic film is dependent 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 solution crossover device before the dryer. The optimum conditions for drying film must be determined for each processor, making allowance for film moisture content and static buildup. 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.

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

- using multi-stage counter-current-flow washes
- installing solution crossover devices 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 solution crossover devices and counter-current stages can be substantial. A three-stage counter-current final wash with solution crossover devices before and after each stage requires approximately 1/25 of the water of a single-stage wash with entrance and exit solution crossover devices. 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 table on page 18 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 solution crossover devices 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 solution crossover device efficiencies have been established.

Mixing Instructions

Chemical	Mixing Instructions	One KODAK Kit Makes
First Developer Tank Solution	Important: To prepare a machine solution from the First Developer Replenisher Kit, you must use KODAK B&W Reversal First Developer Starter, CAT 7504723. TO PREPARE 75.7 LITRES • 20 GALLONS OF MACHINE SOLUTION:	20 gallons
First Developer Replenisher Solution	TO PREPARE 57 LITRES • 15 GALLONS OF DEVELOPER SOLUTION:	15 gallons
Bleach Tank Solution	To mix bleach tank solution, mix three parts water with one part bleach replenisher solution.	
Bleach Replenisher Solution	TO PREPARE 75.7 LITRES • 20 GALLONS OF SOLUTION: STIR EACH PART UNTIL DISSOLVED BEFORE ADDING NEXT PART.	20 gallons
Clearing Bath Replenisher Solution	TO PREPARE 57 LITRES • 15 GALLONS OF CLEARING BATH SOLUTION:	15 gallons
Clearing Bath Tank Solution	TO PREPARE 75.7 LITRES • 20 GALLONS OF TANK SOLUTION:	20 gallons
Redeveloper Tank Solution	TO PREPARE 75.7 LITRES • 20 GALLONS OF TANK SOLUTION:	20 gallons
Redeveloper Replenisher Solution	TO PREPARE 57 LITRES • 15 GALLONS OF REPLENISHER SOLUTION:	15 gallons
Fixer Tank and Replenisher Solution	TO PREPARE 19 LITRES • 5 GALLONS OF FIXER TANK & REPLENISHER FOR FILMS:	5 gallons

Procedure to Convert from Dichromate Bleach to Permanganate Bleach

1. Dispose of the dichromate bleach following your local disposal regulations.
2. Dump the wash tank just after the bleach.
3. Remove filters in both re-circulation systems.
4. Remove any dirt, sediment or sludge by flushing them with water.
5. In case of dichromate deposit/residue, remove the bulk of the residue before conversion. This may require the use of a soft brush to remove any deposit from processor rollers and tank walls.
6. Fill both tanks with water and let water recirculate 5 to 10 minutes.
7. Dump the water.
8. Re-do step 5 and 6 until any traces of bleach are removed (3 or 4 times for the bleach, 1 or 2 times for the wash).
9. Dump the bleach in the bleach replenisher line following your local regulations.
10. Rinse the replenisher tank and line 3 or 4 times with water.
11. Fill the machine and the replenisher tank with the new bleach.
12. Run control strips to be sure the sensitometry of the process is in control.

Don't forget to put new filters in the re-circulation line. If the residue in step 5 is difficult to clean, a solution of sodium metabisulfite, 10 - 20 g/L of water may be used. Be sure to rinse the tanks with clean water after using this solution, before proceeding to step 6.

The new permanganate bleach should not be used with pumps that have polypropylene components. Polypropylene has been found to exhibit stress fractures when exposed to the permanganate bleach. It is very likely that a pump constructed with polypropylene components would suffer damage that would result in catastrophic failure of the pump. It is strongly recommended that other materials be considered for use with pumps and in other applications where stress fractures may develop. Plastic materials such as PVC, ETFE (Ethylene Tetrafluoroethylene), PVDF, and Kynar, etc., are more resistant to permanganate bleach and should be used in place of polypropylene.

The permanganate bleach has a dark purple color. This may make it difficult to read your flowmeter for the bleach tank.

A variety of flowmeters are available for use with dark solutions such as the permanganate bleach. Two examples are a variable-area flowmeter with an analog display and a paddle-wheel flowmeter with LCD display. If your flowmeter can be disassembled, the dark colored float can be replaced with a white colored one. The flowmeter must be recalibrated if the float is changed. Another option is to read the position of the dark ball in the flowmeter with a laser pointer.

Construction Materials

The construction materials recommended for the developer, bleach, clearing bath, and fixer solutions are listed in the table below. The permanganate bleach is quite corrosive. Titanium, Hastelloy C, and engineering plastics such as PVC are, therefore, recommended materials for permanganate bleach. Use of plastics compatible with low pH solutions (less than pH 5) may be acceptable depending upon their application. Some materials such as Polypropylene and Nylon are not recommended for use with this permanganate bleach. Certain plastic materials, such as ETFE (Ethylene Tetrafluoroethylene), PVDF, and Kynar, etc., are more resistant to this particular bleach and better used in certain applications such as pumps.

Additional information on materials construction and information on their use are given in KODAK Publication No. K-12, Construction Materials for Photographic Processing Equipment. You may also contact the Kodak Information Center at 1-800-242-2424.

Construction Materials for B&W Reversal Process

Solution	Plastics (Polyvinyl Chloride or ETFE)	Titanium	Hastelloy C	Austenitic Stainless Steel AISI Type 316 ^a
Permanganate Bleach				
Tanks and Racks	b	*	*	
Mixing Tanks	b	*	*	
Replenisher Holding Tanks	b	*	*	
Piping, Pumps, Valves, and Filter Cores	b	*	*	
Overflow Holding Tank	b	*	*	
Others:				
Tanks and Racks	*	*	*	*
Mixing Tanks	*	*	*	*
Replenisher Holding Tanks	*	*	*	*
Piping, Pumps, Valves, and Filter Cores	*	*	*	*

^a AISI Type 316 Stainless Steel has been extensively tested and is satisfactory for the uses listed in the table above. Refer to The SPSE Handbook of Photographic Science and Engineering, Materials of Construction for Photographic Processing Equipment Section, for information on other Austenitic Stainless Steels.

^b Plastics compatible with pH solutions should be used (e.g., polyvinyl chloride, ETFE, PDVF, Kynar). The compatibility of other plastics should be evaluated under actual use.

Permanganate bleach should not be used with pumps that have polypropylene components. Polypropylene has been found to exhibit stress fractures when exposed to the permanganate bleach. It is very likely that a pump constructed with polypropylene components would suffer damage that would result in catastrophic failure of the pump. It is strongly recommended that other materials be considered for use with pumps and in other applications where stress fractures may develop. Plastic materials such as PVC, ETFE (Ethylene Tetrafluoroethylene), PVDF, and Kynar, etc., are more resistant to permanganate bleach and should be used in place of polypropylene.

PROCESS MONITORING

This section describes:

- Introduction
- Terms used in process monitoring and troubleshooting
- How to monitor your process
- Storing, handling, and processing control strips
- Plotting control-strip densities for the B&W Reversal Process
- 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 such as under- or over-development.

- *Under-development* in the B&W reversal process first developer will result in an increase in density in your control strips for your processes.
- *Over-development* will produce a decrease in density in your control strips.

When the control plot shows a problem, you may also see the problem in customer orders. Checking only the control plots may not always isolate the problem, because using incorrect or improperly stored strips may yield false information. To find the cause of any problem, check the control plots first and then visually review appropriate customer orders.

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 density, then apply the correction factors to the density readings. Enter these values in the spaces provided on the left side of your control chart.

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.

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 No. H-24, Processing KODAK Motion Picture Films. for more information on limits and adjustment tolerances.

Tolerance Limits

B&W Reversal Process

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

How to Monitor Your Process

To begin process monitoring, you will need—

- KODAK TRI-X Reversal Control Strips for Black-and-White Processing
- An electronic densitometer
- KODAK Process Record Form H-24F, Y-55, or similar graph paper
- pencils

KODAK Control Strips

KODAK Control Strips are no longer available.

KODAK TRI-X Reversal Control Strips for Black-and-White Processing were packaged in 100-foot rolls containing at least 120 exposures, and a processed reference strip.

The exposures on the roll were spaced at 9.5-inch intervals. Each exposure had 11 gray-scale steps at 0.30 log H increments (1 camera stop). See the figure on page 24.

Process Control Strip

Step 5 LD



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 contained process deviation (correction) factors, if they were 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. Lastly, the control-strip code is in the format WXYZ, W=year, XY=month, Z is format (1 = 35 mm, 2 = 16 mm).

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. (Keep frozen—allow no more than one hour per day outside of the freezer.) Store your daily supply of control strips in a lighttight 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 in 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 11-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 to room temperature before processing them. Store the reference strip in its envelope when not in use.

To ensure consistency in process monitoring, use of fresh control strips is critical. 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. 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 for as long as possible.

Processing Control Strips

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

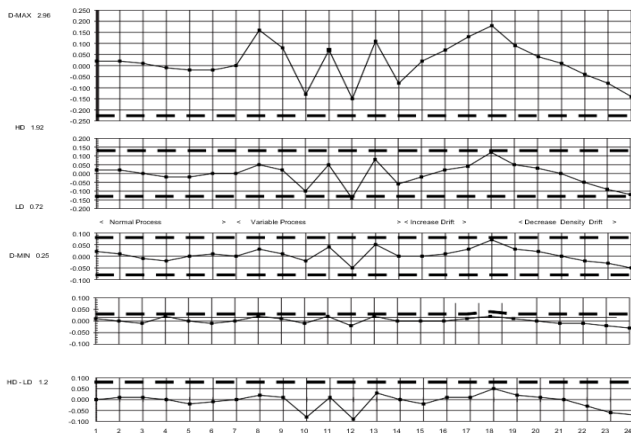
- at the beginning of the day or shift, before processing customer work
- at regular intervals with customer work
- at the end of the day or shift

The 30.5-metre (100-foot) roll of control strips is wound with the emulsion side in and with the high-density end of each strip toward the outside of the roll. The high-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 26. For more information about setting up a control plot and using control strips, see KODAK Publication No. H-24, *Processing KODAK Motion Picture Films*.

Typical Control Chart for B&W Reversal Process



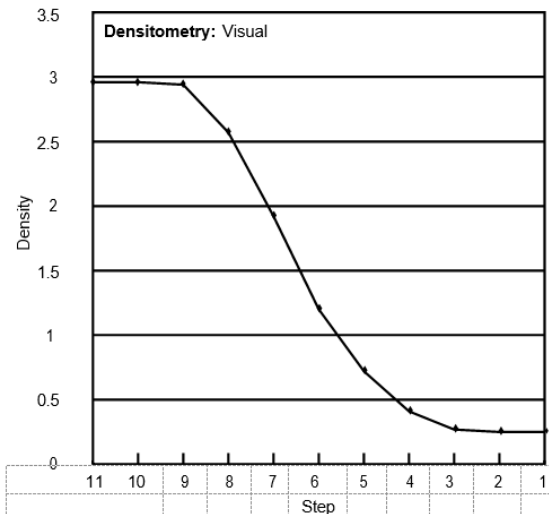
1. Draw in the action and control limits given in the appropriate table. Use black for the action limits and red for the control limits.
2. Allow the reference strip to warm to room temperature (about 15 minutes) and then remove it from its envelope. Exposing a frozen strip to warm, moist air can cause low readings, particularly in the higher density patches.
3. Measure the visual density 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 identify each batch.

Control Steps

B&W Reversal Process
D-min (Step 1)
LD (Step 5)
HD (Step 7)
D-Max (Step 11)
HD-LD (Steps 7 - 5)

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). 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.

KODAK TRI-X Reversal Film 7266



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

Typical Correction Factors for the B&W Reversal Process

Code Number 1088	Visual Density
D-min (Step 1)	-0.01
LD (Step 5)	0.00
HD (Step 7)	0.03
D-Max (Step 11)	0.02

Calculating Aim Values for B&W Reversal Process

Code Number 1088	Reference Strip Densities	Correction Factor	Aim Densities
D-Min (Step 1)	0.24	- 0.01	0.23
LD (Step 5)	0.89	0.00	0.89
HD (Step 7)	1.87	0.03	1.90
D-Max (Step 11)	2.96	0.02	2.98
Note: Using Values from <i>Typical Correction Factors for the B&W Reversal Process</i> above.			

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.
 - a) Plot differences that are larger than the corresponding aim values (+ values) above the aim line.
 - b) 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

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.
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. 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. 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 the old and new aim numbers while making the daily notations.
8. If 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 probably involves all aspects of the process, not necessarily a problem with the new batch of control strips. If difficulty continues, contact your Kodak representative.

Y-55 Plot Batch Change



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. 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.

The table below is a troubleshooting guide for reversal processing. The table covers many common occurrences and can be very helpful if you encounter any processing difficulties. For assistance or further information, contact one of the Entertainment Imaging offices listed in Kodak Locations, or call the Kodak Information Center at 1-800-242-2424, Monday through Friday, 8 a.m. to 9 p.m. (eastern time).

Reversal Process Variations

Problem	Possible Cause
High overall density	First developer • short time • low temperature • under-replenishment, solution exhaustion • improper mixing • excessive oxidation • insufficient agitation
Low overall density	First developer • long time • high temperature • over-replenishment • improper mixing • light fog • creation of sodium sulfide in the first developer
Low contrast or low D-max	Second developer • short time • low temperature • under-replenishment, solution exhaustion • carry-over of bleach and clearing bath • improper mixing

Problem	Possible Cause
Nonuniform density	• oil on film before processing • inadequate clearing bath • poor bleach agitation • too strong or too weak clearing bath • retained silver halide • poor crossover solution crossover devices
Dark or light spots	• bleach too concentrated in potassium permanganate • bleach over-replenishment
Curtains (streaks)	• improper developer turbulation • bleach under-replenishment, solution exhaustion • too strong a clearing bath
Repeating, equally spaced dots	• emulsion in contact with soft-touch tire on a processing machine roller
Scallops on the film edge, repeating	• roll of film dropped on a hard surface • intermittent high tension in processor
Fine streaks	• worn or misaligned wiper-blade • scratches
Fuzzy spots	• air bubbles on the film surface in the first developer

Pressure marks (light or dark)	pinching, buckling, or physical pressure on unprocessed film, before or after exposure
Static marks	- rapid rewinding of film in low relative humidity - improper grounding of equipment
Scratches	- old, hard, worn, crystal-laden, maladjusted solution crossover devices or spools - cinching a roll of film before or after processing - improper loading of camera magazine or processing machine - machine spools that are not rotating freely or are out of line - improper machine threading (film twisted)
Reticulation--irregular lines, resembling a net	- high solution temperature - dryer temperature too high or relative humidity too low - large temperature differences between solutions
Normal low density, low upper densities, low D-max	- light or chemical fog - time too long in strong clearing bath - re-exposure inadequate, uneven, or omitted

Problem	Possible Cause
Increased D-min, and density in low-density areas	- inadequate clearing - insufficient wash after first developer - bleach under-replenishment, solution exhaustion
Dirt (on original)	dust, cloth fragments, hair, skin flakes, chemical crystals, etc.--most easily seen under high-intensity specular lighting or as dark specks on a projection
Yellow specs on the emulsion surface	- sulfur particles formed in the fixer caused by low pH - sulfur from silver recovery cells
Emulsion skivings	small shreds of emulsion sheared from the film edges by machine spools that are improperly aligned or have burrs, and deposited on the base or emulsion
Irregular, shiny areas on the emulsion surface (ferrotyping)	- high windup tension on unprocessed film - rewinding cold, unprocessed or processed film that has not reached room temperature (condensation moisture) - wet or tacky emulsion at processor windup
Tacky film	- inadequate final processing solution crossover device action - inadequate drying conditions
Water spots	- surface water carried into the dryer by the film - hard water--add sequestering agent to the final wash
Scalloped or fluted edges	excessive tension on the film
Small round craters on the emulsion	differential drying--a liquid being spraying on the emulsion surface after final solution crossover device
Shore line	- too much water being carried into drying cabinet in perforation area - impingement drying--temperature too high
Particles--black lines and comets	- flocculent silver flakes that were not removed from the fixer - the fixer exit solution crossover device smears adhering flakes into lines of comets

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 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 28). 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 the correct visual filter.**

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 VISION Color Negative Control Strips*.

This information is also available on the Kodak website at:

<https://www.kodak.com/en/motion/page/processing-manuals/>

APPENDIX

Film Handling

This section includes:

- Designated Films
- Film Storage and Handling
- Other Film Characteristics

Designated Films

Camera Films

KODAK TRI-X Reversal Film 7266

For information on exposure index, lighting, color balance, required filters, 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. 7266.

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-23, *The Book of Film Care*.

Exercise care when handling negative films to avoid scratches and/or dirt that will be noticeable on the final projection. Have film handlers use lint-free nylon or DACRON gloves and handle the film by the edges. Further suggestions on how to keep camera or preprint films clean are in KODAK Publication

No. H-24, *Processing KODAK Motion Picture Films, Module 2, Equipment and Procedures*.

Other Film Characteristics

For information on the physical characteristics of KODAK Motion Picture Films (including edge identification, perforations, and dimensional change characteristics), as well as cores, spools, winding, and packaging, refer to KODAK Publication No. H-1, *KODAK Motion Picture Film*.

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

Conversion Factors

To Convert	Multiply By
Milliliters to Fluid ounces	.03382
Fluid ounces to Milliliters	29.573
Pints to Liters	.4732
Liters to Pints	2.113
Quarts to Liters	.9463
Liters to Quarts	1.057
Gallons to Liters	3.785
Liters to Gallons	.2642

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

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

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

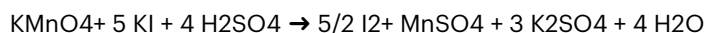
$$C = (F - 32) \div 1.8$$
2. To convert Celsius to degrees Fahrenheit, multiply the Celsius temperature by 1.8. Then add 32 to the result.

$$F = (C \times 1.8) + 32$$

IODOMETRIC DETERMINATION OF POTASSIUM PERMANGANATE IN PERMANGANATE BLEACHES (B&W REVERSAL)

Introduction

Using this analytical procedure you may determine potassium permanganate in permanganate bleach samples (Black-and-White Reversal). Potassium iodide is added to an acidified solution of the sample. The solution is allowed to stand for 15 minutes in the dark. The iodine formed is titrated with standard sodium thiosulfate either potentiometrically or manually with a visual, starch end point. The Permanganate content is equivalent to the iodine formed.



Two procedures are proposed: the potentiometric titration (procedure A) and the visual end point titration (procedure B).

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

Procedure A - Potentiometric Titration

PRECISION AND BIAS

Repeatability Standard Deviation (1Sr) & 95% Confidence Estimate Repeatability standard deviation is an estimate of variability one trained analyst should be able to obtain under favorable conditions (analyzing a sample, with one instrument, within one day).

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

To obtain the repeatability data, a single skilled analyst performed 5 replicates on each of following solutions over one day during methods development.

1. A fresh permanganate bleach was prepared with all components (at the concentration of 1.98 g/L KMnO_4).
2. A seasoned permanganate bleach analyzed as received, at 6.56 g/L.
3. The same "seasoned" solution as in number 2, above, was reanalyzed after making an analytically weighed, standard addition of 2.14 g/L KMnO_4 .

Potassium Permanganate

Sample	Mean g/L	N	Repeatability Standard Deviation (1Sr) g/L	95% Confidence Estimate g/L
"Fresh" at 1.98 g/L KMnO_4	2.00	5	0.016	± 0.04
Seasoned as received	6.56	5	0.026	± 0.07
Seasoned plus addition	8.59	5	0.097	± 0.27

Bias—A bias of + 0.02 g/L potassium permanganate was determined for the fresh bleach sample to compare with theoretical concentration. However, the difference at the 95% confidence level was judged not to be practically significant.

Bias is a statistically significant deviation of the mean from the known permanganate level at a 95% confidence level. It is determined for fresh samples only. Bias was not determined for these seasoned samples, because the component concentration level was not determined independently of the test method.

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

The recovery of the standard addition sample was 94.9% and found to be statistically different from 100% at the 95% confidence level. However, it was judged not to be practically different from 100%.

Reproducibility (Customer Standard Deviation, 1Sc) and 95% Confidence Estimate

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

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

Five bleach samples were analyzed by two analysts, on four days. These samples were:

1. Three "fresh" bleach samples were prepared with all components at their respective concentrations 1.98 g/L, 4.01 g/L and 10.28 g/L KMnO₄.
2. A seasoned permanganate bleach analyzed as received, at 6.59 g/L
3. The same "seasoned" solution as in number 2, above, was reanalyzed after making an analytically weighed, standard addition of 2.14 g/l KMnO₄.

Potassium Permanganate

Sample	Mean g/L	N	Reproducibility Standard Deviation (1Sc) g/L	95% Confidence Estimate g/L
"Fresh" at 1.98 g/L KMnO ₄	1.99	10	0.016	± 0.04
"Fresh" at 4.01 g/L KMnO ₄	4.03	10	0.032	± 0.07
"Fresh" at 10.28 g/L KMnO ₄	10.26	10	0.063	± 0.14
Seasoned as received	6.59	10	0.048	± 0.11
Seasoned plus addition	8.57	10	0.053	± 0.12

Bias Bias is a statistically significant deviation of the mean from the known permanganate level at a 95% confidence level. It is determined for fresh samples only. Bias was not

determined for these seasoned samples, because the component concentration level was not determined independently of the test method.

Bias of + 0.01 g/L for the first sample, + 0.02 g/L for the second and the third sample potassium permanganate were determined for the fresh bleach sample to compare with theoretical concentration. However, the difference at the 95% confidence level was judged not to be practically significant.

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

The recovery of the standard addition sample was 92.5% and found to be statistically different from 100% at the 95% confidence level. However, it was judged not to be practically different from 100%.

SPECIAL APPARATUS

- PAAR DMA- 46 density meter or equivalent
- Titrimetric DMS, Metrohm or equivalent with a Dosimat and a 20 mL burette
- Reference Electrode, Ag/AgCl (filled with KCl 3.5M). Metrohm model 6.0733.100 or equivalent.
- Indicator Electrode, platinum, Metrohm Model 6.0301.100 or equivalent
- Balance, 0.001 gram capacity
- Stir bars, TEFLON-coated
- 200 mL beaker
- Pipets (5 mL, 10 mL)
- Parafilm

Note: 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.

REAGENTS

Use reagents that are ACS Reagent Grade unless specified otherwise.

- 0.1 N Sodium Thiosulfate $\text{Na}_2\text{S}_2\text{O}_3$, standardized to four significant figures
- Concentrated Hydrochloric Acid (HCl)
- Potassium iodide (KI)
- Water, Type I Reagent – This method was developed using reagent water equivalent to or 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

Solution specific gravity

Measure the specific gravity at 20°C following KODAK Publication No.

H-24, Processing *KODAK Motion Picture Films, Module 3, Analytical Procedures*, "The Determination of Specific Gravity for Photoprocessing Solutions Using Hydrometers" or equivalent. Method # ULM-0002/1.

Sample treatment:

- Weigh 3 grams of potassium iodide in a 200 mL beaker.
- Add 100 mL reagent water and a TEFLON-coated stirring bar.
- Seal with parafilm and swirl the flask to dissolve the potassium iodide.
- Place the beaker on the balance and tare.
- Pipet the sample size indicated below into the tared beaker.

Process	Sample Size (mL)
Fresh bleach	10.0
Seasoned bleach (tank)	10.0
Replenisher bleach	5.0

- Weigh the beaker with the added sample to the nearest 0.001 g. Record as the sample weight.
- Add 5 mL of concentrated hydrochloric acid to the beaker.



Caution

Always add acid to water and not the reverse.

- Seal with parafilm and swirl the beaker and store in a dark place for 15 minutes.
- After 15 minutes, remove the beaker from the dark and titrate with standardized 0.1 N sodium thiosulfate.

Titration:

Set the following parameters on the Metrohm Titrino 716

- titration mode:
 - MET U (Monotonic Equivalence point Titration)
- titration parameter:
 - increment volume 1.25 mL
 - titration flow 7 mL/min
 - start volume no
 - waiting time 5 s
 - automatic titration stop off
- Electrodes:
 - Reference Electrode, Ag/AgCl (filled with KCl 3.5M). Metrohm model 6.0733.100 or equivalent
 - Indicator Electrode, platinum, Metrohm Model 6.0301.100 or equivalent
- Place the beaker on the titrator stand and add a magnetic stir bar.
- Place the electrodes in the beaker.
- Set the stirrer speed to stir rapidly without splashing or creating a vortex.
- Titrate the solution potentiometrically with standardized 0.1 N sodium thiosulfate solution through the inflection.
- Determine the volume, in mL, of 0.1 N sodium thiosulfate added to reach the end point.
- Record this volume as Volume Na₂S₂O₃ in mL.

CALCULATION

$$\frac{\text{KMnO}_4 \text{ (g/L)} = \text{mL Na}_2\text{S}_2\text{O}_3 \times \text{N Na}_2\text{S}_2\text{O}_3 \times 31.61 \times \text{solution specific gravity}}{\text{Grams sample}}$$

Example:

If mL 0.1000 Na₂S₂O₃ = 12.540

Grams sample = 20.584

Solution specific gravity = 1.024

$$\text{g/L KMnO}_4 = 12.54 \times 0.1000 \times 31.61 \times 1.024$$

20.584

KMnO₄ = 1.97 g/L

Procedure B - Visual Titration

PRECISION AND BIAS

Repeatability Standard Deviation (1Sr) & 95% Confidence Estimate The 95% confidence estimate (calculated using the repeatability standard deviation) around a single test result will include the mean value 95% of the time. To obtain the repeatability data, a single skilled analyst performed 5 replicates on each of following solutions over one day during methods development.

1. A fresh permanganate bleach was prepared with all components (at concentration of 1.98g/L KMnO₄).
2. A seasoned permanganate bleach analyzed as received, at 6.43 g/L KMnO₄.
3. The same "seasoned" solution as in number 2, above, was reanalyzed after making an analytically weighed, standard addition of 2.14 g/L KMnO₄.

Potassium Permanganate

Sample	Mean g/L	N	Reproducibility Standard Deviation (1Sc) g/L	95% Confidence Estimate g/L
"Fresh" at 1.98 g/L KMnO ₄	1.98	5	0.011	± 0.03

Seasoned as received	6.43	5	0.029	± 0.08
Seasoned plus addition	8.67	5	0.045	± 0.12

Bias—Bias is a statistically significant deviation of the mean from the known permanganate level at a 95% confidence level. It is determined for fresh samples only. Bias was not determined for these seasoned samples, because the component concentration level was not determined independently of the test method. No statistically significant bias was found for the fresh bleach sample to compare with the theoretical concentration.

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

The recovery of the standard addition sample was 104.7% and found to be statistically different from 100% at the 95% confidence level. However, it was judged not to be practically different from 100%.

Reproducibility (Customer Standard Deviation, 1Sc) and 95% Confidence Estimate

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

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

Five bleach samples were analyzed by two analysts, on four days. These samples were:

1. Three "fresh" bleach samples were prepared with all components at their respective concentrations 1.98 g/L, 4.01 g/L and 10.28 g/L KMnO₄.
2. A seasoned permanganate bleach analyzed as received, at 6.59 g/L.
3. The same "seasoned" solution as in number 2, above, was reanalyzed after making an analytically weighed, standard addition of 2.14 g/L KMnO₄.

Potassium Permanganate

Sample	Mean g/L	N	Reproducibility Standard Deviation (1Sc) g/L	95% Confidence Estimate g/L
"Fresh" at 1.98 g/L KMnO ₄	1.97	10	0.009	± 0.02
"Fresh" at 4.01 g/L KMnO ₄	3.99	10	0.027	± 0.06
"Fresh" at 10.28 g/L KMnO ₄	10.26	10	0.061	± 0.14
Seasoned as received	6.59	10	0.059	± 0.14
Seasoned plus addition	8.60	10	0.060	± 0.14

Bias—Bias is a statistically significant deviation of the mean from the known permanganate level at a 95% confidence level. It is determined for fresh samples only. Bias was not determined for these seasoned samples, because the component concentration level was not determined independently of the test method. Bias of + 0.01 g/L for the first sample, + 0.02 g/L for the second and the third sample potassium permanganate were determined for the fresh bleach sample to compare with theoretical concentration. However, the difference at the 95% confidence level was judged not to be practically significant.

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

The recovery of the standard addition sample was 92.5% and found to be statistically different from 100% at the 95% confidence level. However, it was judged not to be practically different from 100%.

SPECIAL APPARATUS

- PAAR DMA- 46 density meter or equivalent
- Buret, 20 mL
- Balance, 0.001 gram capacity
- Stir bars, TEFLON-coated
- 200 ml beaker
- Pipets (5 mL, 10 mL)
- Parafilm

Note: 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.

REAGENTS

Use reagents that are ACS Reagent Grade unless specified otherwise

- 0.1 N Sodium Thiosulfate $\text{Na}_2\text{S}_2\text{O}_3$, standardized to four significant figures
- Concentrated Hydrochloric Acid (HCl)
- Potassium iodide (KI)
- Starch indicator

PROCEDURE

Solution specific gravity

Measure the specific gravity at 20°C following KODAK Publication No. H-24, Processing KODAK Motion Picture Films, Module 3, Analytical Procedures, "The Determination of Specific Gravity for Photoprocessing Solutions Using Hydrometers" or equivalent. Method # ULM-0002/1.

Sample treatment:

- Weigh 3 grams of potassium iodide in a 200 mL beaker.
- Add 100 ml reagent water and a TEFLON-coated stirring bar.
- Seal with parafilm and swirl the flask to dissolve the potassium iodide.
- Place the beaker on the balance and tare.
- Pipet the sample size indicated below into the tared beaker.

Process	Sample Size (mL)
Fresh bleach	10.0
Seasoned bleach (tank)	10.0
Replenisher bleach	5.0

- Weigh the beaker with the added sample to the nearest 0.001 g. Record as the sample weight.
- Add 5 mL of concentrated hydrochloric acid to the beaker.



Caution

Always add acid to water and not the reverse.

- Seal with parafilm and swirl the beaker and store in a dark place for 15 minutes.
- After 15 minutes, remove the beaker from the dark and add 3 mL of starch indicator solution.

Titration

- While stirring, immediately titrate with standardized 0.1000 N sodium thiosulfate solution (20 mL burette).
- Titrate, drop by drop until the disappearance of the blue color for at least 15 seconds.
- Record this volume as Volume $\text{Na}_2\text{S}_2\text{O}_3$ (mL).

CALCULATION

$$\text{KMnO}_4 \text{ (g/l)} = \text{mL Na}_2\text{S}_2\text{O}_3 \times \text{N Na}_2\text{S}_2\text{O}_3 \times 31.61 \times \text{solution specific gravity}$$

Grams sample

Example:

$$\text{If ml } 0.1000 \text{ Na}_2\text{S}_2\text{O}_3 = 12.540$$

$$\text{Grams sample} = 20.584$$

$$\text{Solution specific gravity} = 1.024$$

$$\text{g/L KMnO}_4 = 12.54 \times 0.1000 \times 31.61 \times 1.024$$

$$20.584$$

$$\text{KMnO}_4 = 1.97 \text{ g/L}$$

Two procedures are proposed, the potentiometric titration (procedure A) and the visual end point titration (procedure B).

For more information on motion picture products, call or write to the Entertainment Imaging office nearest you.

Or access Kodak's home page on the Internet, web site address— <https://www.kodak.com/go/motion>

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Using KODAK B&W Reversal Chemicals in Motion Picture Film Laboratories
KODAK Publication No. **H-661**

09-26