Processing KODAK Color Print Films, Module 9

Process ECP-2E Specifications

Table of Contents

FILMS AND PROCESS SEQUENCE 9-1
Designated Films 9-1
Film Structure 9-1
Process ECP-2E Steps 9-2
Alternative Ferricyanide or UL Bleach Sequence 9-2
Safelights for Darkroom Illumination 9-2
Film Storage and Handling 9-2
Other Film Characteristics 9-2
PROCESSING MACHINE DESIGN AND CONSTRUCTION 9-3
Machine Design 9-3
Construction Materials 9-6
Filters 9-8
Crossover Squeegees 9-8
Dryer Cabinet 9-8
Film Lubrication 9-8
Machine Exhaust and Room Ventilation Systems 9-9
Countercurrent Washes 9-9
OPERATING SPECIFICATIONS 9-9
Mechanical Specifications 9-9
UL Bleach Formulations 9-13
Conversion to UL Bleach 9-13
Drying Specifications 9-14
Turbulation Specifications 9-14
Wash-Water Flow Rates 9-15
Stop Wash 9-15
Bleach Wash 9-15
Final Wash 9-15
Rewashing 9-15
PROCESSING CHEMICALS AND FORMULAS 9-16
Packaged Chemicals 9-16
Bulk Chemicals 9-16
Solution Mixing 9-19
Formulas and Analytical Specifications 9-20
Storage of Solutions 9-27
OPTICAL SOUND PROCESSING 9-27
Overview 9-27
Sound Track Operating Specifications 9-27
Sound Track Control 9-27
MORE INFORMATION 9-28

9 PROCESS ECP-2E SPECIFICATIONS

This module contains specifications describing continuous machine processing of Kodak color print films. The following modules are also used in conjunction with Process ECP-2E. Process ECP-2E differs from Process ECP-2D in that there is no first fix or sound application.

Module 10	Effects of Mechanical and Chemical Variations in Process ECP-2E
Module 1	Process Control
Module 2	Equipment and Procedures
Module 3	Analytical Procedures (for Chemical Analyses)
Module 4	Reagent Preparation Procedures (for Chemical Analyses)
Module 5	Chemical Recovery Procedures
Module 6	Environmental Aspects

FILMS AND PROCESS SEQUENCE

Designated Films

KODAK VISION Color Print Film / 2383

Performance Characteristics and Applications: This film is designed for making projection-contrast prints from camera-original color negatives, duplicate negatives, and internegatives made from color reversal originals. Film 2383 has an ESTAR Safety Base.

For information on color balance, image structure, sensitometric curves, printing conditions, and film storage, see KODAK Publication H-1-2383.

KODAK VISION Premier Color Print Film / 2393

Performance Characteristics and Applications: Like its counterpart KODAK VISION Color Print Film, VISION Premier Color Print Film is coated on a polyester base without rem-jet, for a cleaner process and cleaner screen images. The upper tone scale of VISION Premier Color Print Film is significantly higher in density than KODAK VISION Color Print Film, so shadows are deeper, colors are more vivid, and the image snaps and sizzles on the screen. The toe areas of the sensitometric curves are matched more closely, producing more neutral highlights on projection. Cinematographers can be more creative with lighting and exposure, and still see remarkable results.

For information on color balance, image structure, sensitometric curves, printing conditions, and film storage, see KODAK Publication H-1-2393.

KODAK VISION Color Teleprint Film / 2395 / 3395

Performance Characteristics and Applications: KODAK VISION Color Teleprint Film / 2395 / 3395 is specifically designed for making low-contrast contact or optical prints from camera-original negatives, duplicate negatives, and internegatives. This film has been optimized to produce low contrast positive images that closely match the dynamic range of telecine transfer mediums to produce excellent video images.

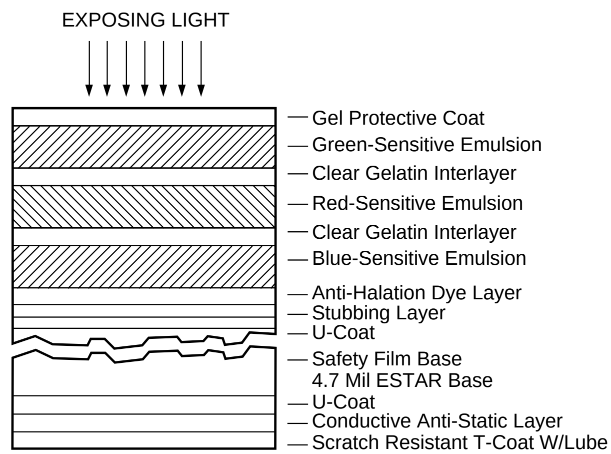
Film 2395 / 3395 is coated on a new ESTAR Base featuring proprietary Kodak technology that replaces rem-jet with process-surviving, anti-static layer, and scratch-resistant backing layer. This film has an efficient antihalation layer under the emulsion layers, using patented solid particle dyes that are decolorized and removed during processing.

For information on color balance, image structure, sensitometric curves, printing conditions, and film storage, see KODAK Publication H-1-2395.

Film Structure

KODAK VISION Color Print Film / 2383, KODAK VISION Premier Color Print Film / 2393 and KODAK VISION Color Teleprint Film / 2395 / 3395 are multi-layer films with incorporated-color couplers. Figure 9-1, is a diagram of the film structure.

Figure 9-1
Cross Section of Unprocessed Color Print Films



This drawing illustrates only the relative layer arrangement of the film and is not drawn to scale.

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The upper green-sensitive layer contains a colorless coupler that is converted to magenta dye during development, proportional to green-light exposure. The next emulsion layer is red-sensitive and contains a colorless coupler that forms a cyan dye, proportional to red exposure. The bottom emulsion layer is blue-sensitive, and contains a colorless coupler that forms a yellow dye, proportional to blue exposure.

The conductive anti-static layer and scratch resistant T-coat with lube are process surviving and retain their properties after processing.

KODAK VISION Color Print Films can be processed without a prebath and rem-jet removal and rinse, as indicated in Table 9-1. These films can be processed directly with the developer solution since they do not have a rem-jet backing to remove.

Process ECP-2E Steps

Table 9-1 Persulfate 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 produce 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. Accelerator	Prepares the metallic silver present for the action of the persulfate bleach.
5. Bleach (persulfate)	Converts the metallic silver from both the sound track image and picture image that was formed during color development, to silver-halide compounds that can be removed by the fixer. In the sound track, the silver image formed during color development is converted to silver halide by the bleach. It is then redeveloped to a silver image by a black-and-white developer solution.
6. Wash	Removes residual bleach from the film, preventing contamination of the following solution.
7. Fixer	Converts the silver-halide compounds formed in the picture area during bleaching to soluble silver thiosulfate complex salts that are removed from the film in this fixer and subsequent wash.
8. Wash	Removes unused fixer and the residual soluble silver thiosulfate complex salts formed during fixing.
9. Final Rinse	Prepares the film for drying.
10. Dryer	Dries film for subsequent handling.
11. Lubrication	Promotes longer print projection life. It may be an in- or off-line operation. See Module 2, *Equipment and Procedures.*

If a customer wishes to retain the first fix and the first fix wash from Process ECP-2D, the sound application may still be skipped by threading the film directly from the bleach wash into the second fix.

Alternative Ferricyanide or UL Bleach Sequence

The steps and their functions are the same as in the recommended process, except the 20-second accelerator and 40-second persulfate bleach is replaced with a 60-second ferricyanide or UL bleach.

Safelights for Darkroom Illumination

When film is handled in a darkroom, whether printer room or processing room, safelights are used to provide enough light for working without fogging the film.

KODAK VISION Color Print Film / 2383, KODAK VISION Premier Color Print Film / 2393 and KODAK VISION Color Teleprint Film / 2395 / 3395 can be handled under illumination provided by standard safelight fixtures fitted with the KODAK No. 8 Safelight Filter / dark yellow. A sodium-vapor lamp fitted with KODAK WRATTEN Gelatin Filters No. 23A and 53 or 57, plus a neutral density filter to reduce the illumination intensity, can also be used. Conduct a careful safelight test before production work is started. The processing steps after the stop bath can be carried out in normal room light.

Film Storage and Handling

Ideally, processed film should be stored at 21°C (70°F) or lower, and 40 to 50 percent relative humidity for short-term or active storage. For long-term storage conditions, store at 2°C (35°F) or lower at a relative humidity of 20 to 30 percent. In general, dye stability during long-term storage improves significantly with reduced temperature. See KODAK Publication No. H-23, *The Book of Film Care*, for more information.

Care must be exercised in the handling of print film to avoid scratches and/or dirt that will be noticeable on the projected print. Film handlers should use lint-free nylon or polyester gloves and handle the film by the edges as much as possible. Suggestions on film handling during processing are presented in 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-1, *KODAK Motion Picture Film*.

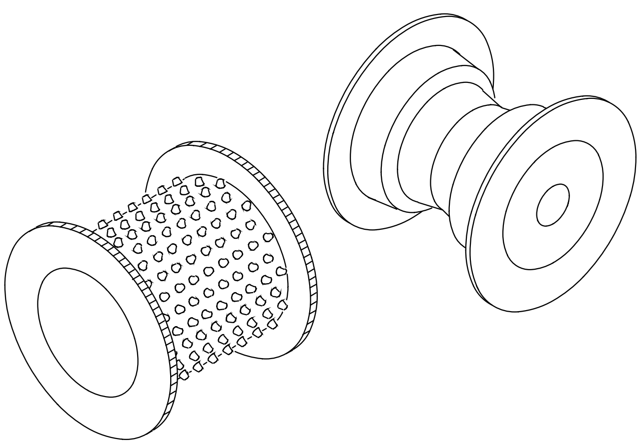
PROCESSING MACHINE DESIGN AND CONSTRUCTION

Machine Design

The films intended for Process ECP-2E are processed in roll form in a continuous processing machine. Film is transported through the various solution tanks, emulsion side out, on a series of spools. These spools are mounted in racks that fit into the tanks, and film is threaded over the spools so that it travels in a continuous spiral on each rack. The film should not be allowed to contact any part of the machine that can damage either the support or the emulsion side of the film. A soft rubber tire has been used successfully on flat spools to create a uniform film-support surface consisting of many soft, flexible fingers.* Such a soft-touch surface, which can be helpful in minimizing physical damage to the film, can be used on all rollers that contact the film base.

Rollers contacting the emulsion should be undercut as shown in Figure 9-2. Soft-touch tires can leave marks on the emulsion. Some machines use undercut rollers with sprockets to drive the film.

Figure 9-2
Soft-Touch Tire (Left) and Undercut Roller (Right)



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The required treatment or solution time for each processing solution and wash is obtained by installing an appropriate number of racks in the various solutions and washes for a specific film transport speed. The size and number of racks are predetermined by the machine manufacturer. Some machine manufacturers build racks with the upper spools fixed and the lower spools mounted on a floater or slider. With such racks, solution times can be controlled by adjusting the positions of the floaters. To provide adequate agitation of the developer at the emulsion surface, the developer tank is equipped with a turbulator. A turbulator is a submerged series of tubes, having nozzles or drilled holes at various locations along the tubes, pointing toward the film strand. The turbulator can be an integral part of the machine rack. For more information on turbulator design, see Module 2, *Equipment and Procedures*.

The processor should be a conventional deep-tank machine. Submerged rollers and rack-drive assemblies are recommended for all solutions to minimize the splattering of solutions and aerial oxidation of the developer and fixer. Figure 9-3 is a schematic of a typical processing machine for Process ECP-2E using the recommended persulfate bleach. Figure 9-4 is a schematic of a typical processing machine for Process ECP-2E using the alternate ferricyanide or UL bleaches. Squeegees should be used at all the locations shown in the schematic to reduce contamination and minimize loss of solution by carry-over into subsequent solutions.

Eastman Kodak Company does not market processing machines or auxiliary equipment suitable for Process ECP-2E. However, a list of some manufacturers of processing equipment can be obtained through the Professional Motion Imaging offices.

* Described in *A Soft-Touch Surface Designed for Scratch-Free Motion-Picture Film Processing*, Journal of the SMPTE, 79:712-715, August 1970.

Figure 9-3 Machine Schematic for Process ECP-2E with Persulfate Bleach Sequence

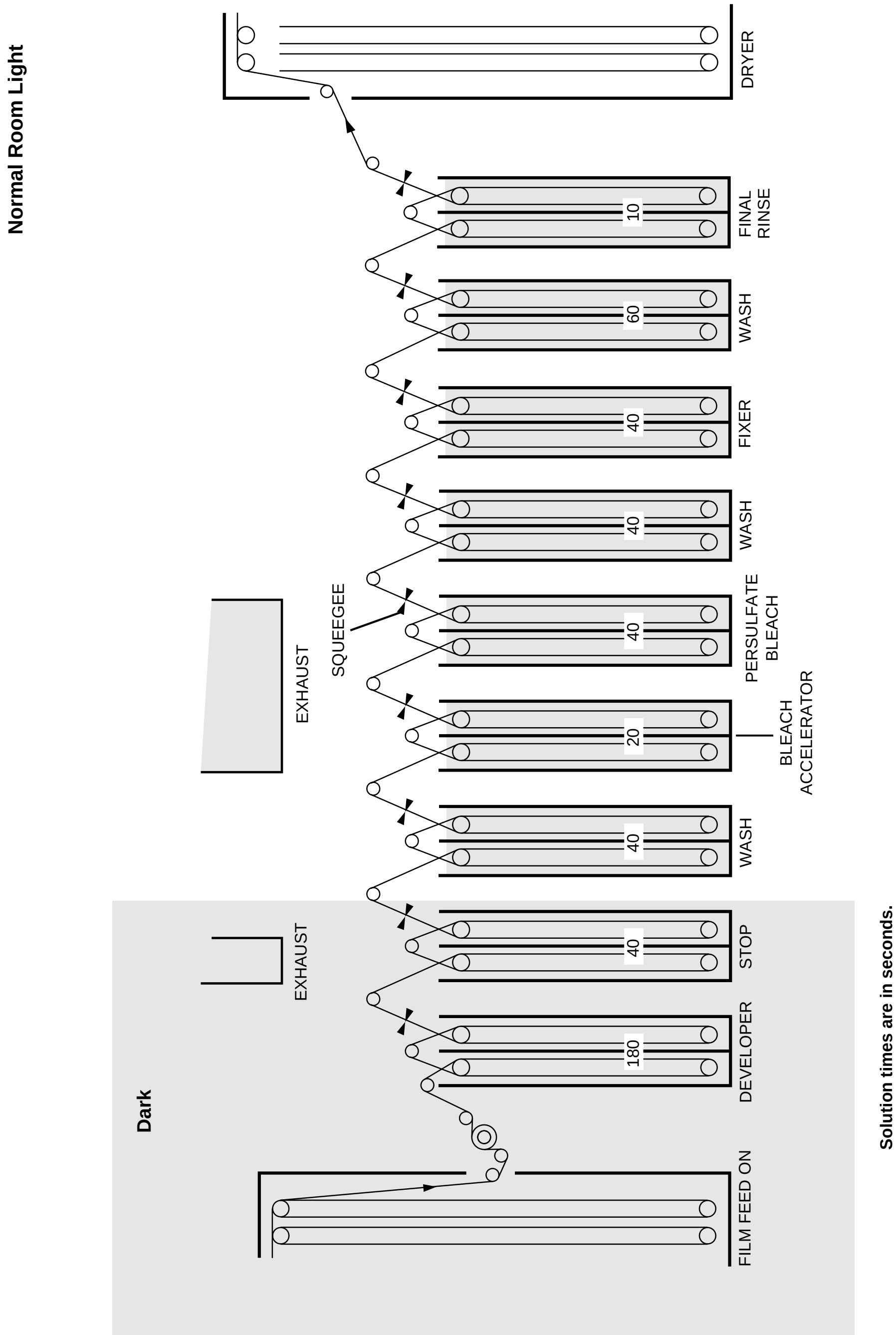

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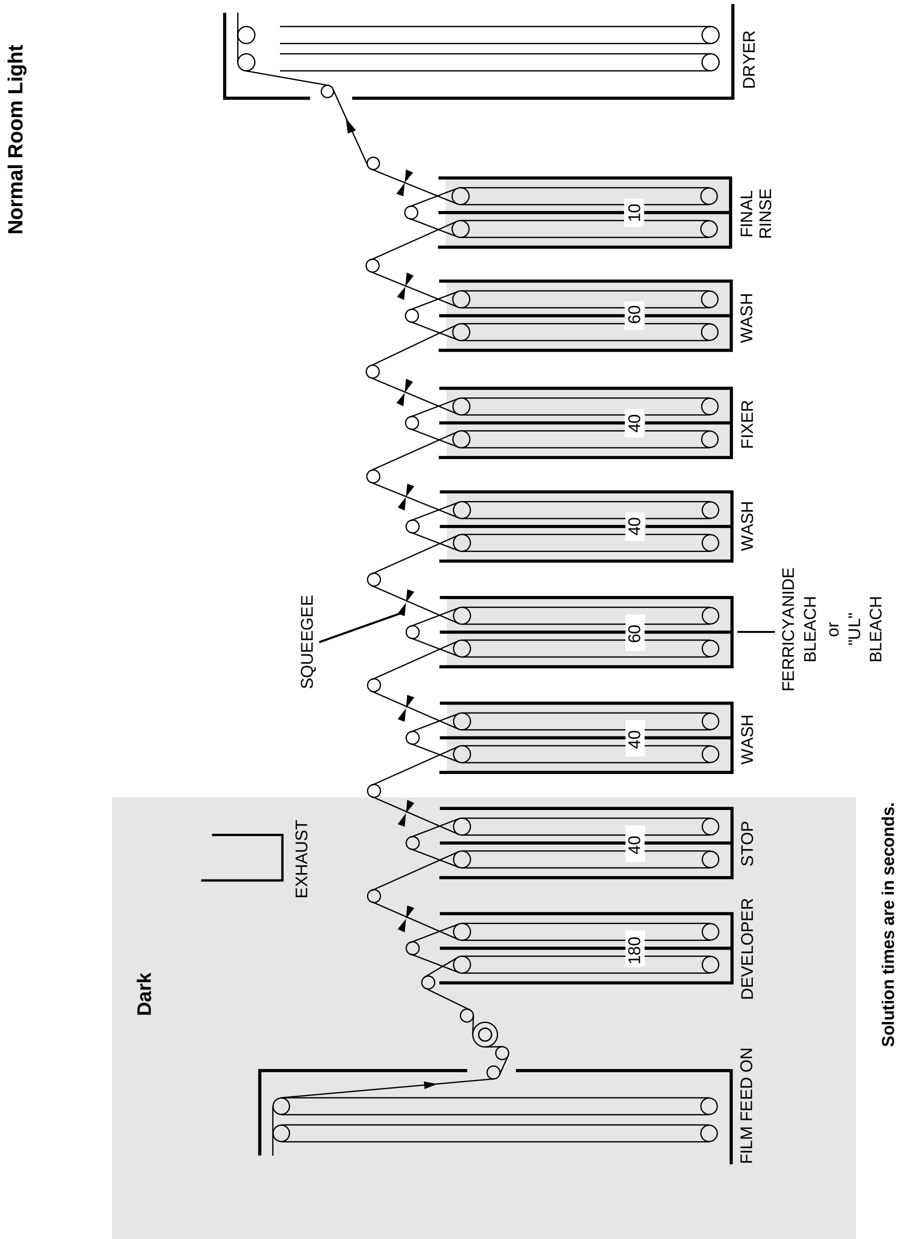
Figure 9-4 Machine Schematic for Process ECP-2E with Ferricyanide or “UL” Bleach Sequence



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Construction Materials

The construction materials recommended for the developer, stop, fixer, and bleach solutions are listed in Table 9-2. All the bleaches are quite corrosive. The UL bleach is slightly more corrosive than ferricyanide bleach, but less corrosive than persulfate bleach. Titanium, Hastelloy C, and engineering plastics such as PVC are, therefore, recommended materials for persulfate bleach. Use plastics compatible with low pH solutions (less than pH 5).

Red brass is commonly found in ferricyanide bleach systems, it will quickly be dissolved by persulfate bleach and UL bleach. In addition to machine tanks, it is often found in fittings, flowmeters, heat exchangers, and valves. Small red-brass parts have been found even when the bleach tank is constructed of titanium, Hastelloy C, or PVC.

The following materials are compatible with ferricyanide or "UL," but not acceptable with persulfate bleach.

Monel is a commonly used staple material; it is dissolved by persulfate bleach in several hours. Stainless-steel staples are recommended for extended lifetime in persulfate bleach. Standard carbon-steel staples will show some corrosion, but maintain their integrity in persulfate bleach much longer than Monel-type staples. In all cases, it is a good practice to avoid extended exposure of staples to any bleach solution.

Some plastic and elastomeric materials will be degraded by persulfate bleach. This degradation is accelerated by the presence of chlorine in the bleach. Some materials known to be degraded by persulfate bleach are low-density polyethylene, acrylonitrile, butadiene, styrene, nylon 6/6, and neoprene. All plastics and elastomeric materials (other than PVC, RTV-60, silicone, and Vitron) should be tested before being used in persulfate bleach. Most plastics, including PVC, will discolor in persulfate bleach, but retain their mechanical properties. Tygon tubing, which turns white, is an example of this effect.

For best process control, equip the holding tank for the color developer replenisher with a tight-fitting floating cover. The cover will minimize air oxidation of the solution, and absorption of carbon dioxide from the air, which would change the pH. Clearance between the cover and the tank wall should not be greater than $\frac{1}{4}$ inch (6.4 mm). Polyethylene sheeting of $\frac{1}{2}$ inch (12.7 mm) thickness makes adequate covers in sizes up to 3 feet (1 metre) in diameter. A dust cover alone permits air to come in contact with the solution and will allow some air oxidation to take place. Dust covers should be used for non-developer solution to minimize dirt in the replenisher tanks.

Additional information on materials construction and information on their use are given in *The SPSE Handbook of Photographic Science and Engineering*, Materials of Construction for Photographic Processing Equipment section. You may also contact the Kodak Information Center at 1-800-242-2424.

Table 9-2 Construction Materials for Process ECP-2E

Solution	Plastics (Polyvinyl Chloride or Polyolefins)	Titanium	Hastelloy C	Austenitic Stainless Steel AISI Type 316 *
Bleach (Ferricyanide or "UL"):				
Tanks and Racks	• †	•	•	
Mixing Tanks	• †	•	•	
Replenisher Holding Tanks	• †	•	•	
Piping, Pumps, Valves, and Filter Cores	• †	•	•	
Overflow Holding Tank	• †	•	•	
Bleach (Persulfate):				
Tanks and Racks	• †	•	•	
Mixing Tanks	• †	•	•	• ‡
Replenisher Holding Tanks	• †	•	•	
Piping, Pumps, Valves, and Filter Cores	• †	•	•	
Overflow Holding Tank	• †	•	•	
Accelerator:				
Tanks and Racks	• †	•	•	•
Mixing Tanks	• †	•	•	•
Replenisher Holding Tanks	• †	•	•	•
Piping, Pumps, Valves, and Filter Cores	• †	•	•	•
Stop:				
Tanks and Racks	• †	•	•	
Mixing Tanks	• †	•	•	• §
Replenisher Holding Tanks	• †	•	•	• §
Piping, Pumps, Valves, and Filter Cores	• †	•	•	
Others:				
Tanks and Racks	•	•	•	•
Mixing Tanks	•	•	•	•
Replenisher Holding Tanks	•	•	•	•
Piping, Pumps, Valves, and Filter Cores	•	•	•	•

* 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.

† Plastics compatible with low pH solutions should be used (e.g., polyvinyl chloride, polypropylene, and high-density polyethylene). The compatibility of other plastics should be evaluated under actual use.

‡ Short-term storage of persulfate bleach in stainless steel tanks is acceptable.

§ Provided the concentration of sulfuric acid specified for the stop is not exceeded and fresh replenisher is always used.

Filters

Filters are used to remove any insoluble material in the form of solids and tars from processing solutions and wash waters. If this material is not removed, it can adhere to the film being processed, machine tank walls, rollers, lines, etc. Filters are required in replenisher lines, recirculation systems, and wash-water lines.

The ideal porosity rating for filters is 10 microns, but the back pressure of a 10-micron filter is sometimes too great to permit adequate flow unless oversize pumps or parallel filters are used. Increasing the filter area will decrease the back pressure, but also increase the cost of filters. Filters with porosity ratings larger than 30 microns will produce low-back pressure, but are of little value in removing insoluble material. Another option is using high-porosity filters in series. The high-porosity filters will slow the clogging of the low-porosity filters.

Establish and follow a definite replacement schedule for filters. Change filters every week or two, or whenever the pressure differential across the filter housing exceeds 10 psig (69 kPa).

Polypropylene, fiber glass, or bleached cotton are acceptable filter media for all Process ECP-2E solutions. *Viscose rayon is not recommended* for use with the developer since it can cause adverse photographic effects. Table 9-2 lists acceptable construction materials for filter cores. Test all filters for adverse photographic effects before use, as described in KODAK Publication No. K-12.

Crossover Squeegees

Processing solution loss and dilution are minimized by crossover squeegees. They wipe solution off both sides of the film strand using plastic blades, air streams, vacuum, buffer plush, or other mechanical means, and direct it back into the originating tank.

A crossover squeegee should be located on the exit strand between stages of all countercurrent washes, and on all Process ECP-2E solutions. Wiper-blade squeegees* (30- to 40-durometer hardness) can be employed, but must be carefully maintained to make sure they do not scratch the film. A general discussion on the use of squeegees is in "A Review of the Effects of Squeegees in Continuous Processing Machines," *Journal of the SMPTE*, 79:121-123, February 1970. Squeegee design details are given in Module 2, *Equipment and Procedures*.

Dryer Cabinet

Carefully control drying of processed film. Insufficient drying may lead to a physical defect called *ferrotyping*. If the film is over-dried, the emulsion becomes brittle and the film tends to curl or flute. Satisfactory drying leaves the film dry without tackiness one half to two thirds of the way through the drying cabinet. Allow the film to cool to room temperature before windup. After cooling, the film should have a moisture content in equilibrium with air at 50 percent relative humidity.

Either an impingement or convection (nonimpingement) dryer can be used. The impingement dryer dries film in a shorter time and occupies less space than most nonimpingement dryers. Regardless of the type, the drying equipment must produce adequate and uniform drying to prevent deformation of the film support or emulsion. Filter the input air to the dryer to remove dust particles that can stick to the film. A high-efficiency particulate air (HEPA) filter, such as the Micretain Equi Flo filter (95 percent efficient at 0.3-micron particle size) is recommended. †

Film Lubrication

Edgewax 35 mm and wider films with a paraffin-based lubricant (approximately 50 g/L). Full coat 16 and 8 mm films with a less dense lubricant such as a 0.5 g/L PE Tetrasterate solution (RP 48-1984). See Module 2, *Equipment and Procedures*, for formulas and details.

* A description of suitable wiper-blade squeegees is presented in "Spring-Loaded Wiper-Blade Squeegees," Journal of the SMPTE 81:742-796, October 1972.

† A product of Cambridge Filter Corporation, 7645 Henry Clay Blvd., Liverpool, NY 13088.

Machine Exhaust and Room Ventilation Systems

Install local exhausts at specific locations on the processing machine and at specific work areas to provide for the safety and comfort of the laboratory personnel. Supplement local exhausts with a room ventilation system having a capacity of 10 air changes per hour. Vent the discharge air from these systems outside the building so that discharged air does not contaminate incoming air.

Locate local exhausts over chemical mixing tanks to remove irritating chemical dust and vapor produced when processing solutions are mixed. Remember to comply with all regulations related to your operations.

Processing machines using persulfate bleach need local exhausts at the stop, accelerator, bleach, and stabilizer. A slot-type exhaust, for example, on the far side of both the accelerator and persulfate bleach will eliminate the accelerator's distinctive odor, and the small amount of chlorine released from the persulfate bleach. This low chlorine lever presents no safety or operational problems but can cause some corrosion of stainless steel and other materials surrounding the bleach tank if not vented properly.

Processing machines with ferricyanide bleach need local exhausts at the stop tank. A slot-type exhaust, for example, on the far side of both the accelerator and persulfate bleach will carry away any sulfur dioxide or hydrogen sulfide generated by developer carried over into the stop.

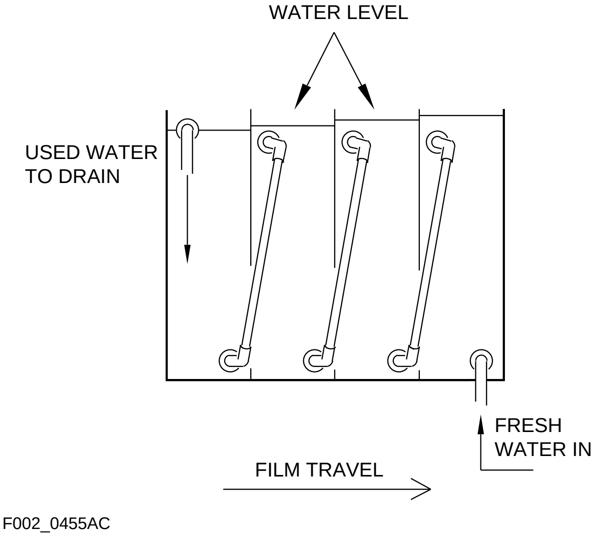
Exhausts need not fit tightly over tanks, and slots should be placed to draw air away from the operator. The exhaust system should provide an air flow of 175 ft^3/min (5 m^3/min) for every square foot (0.09 m^2) of solution surface, and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank.

Countercurrent Washes

Multitank, countercurrent wash methods provide a great savings in water. In this technique, fresh water enters the last tank, flows to the previous tank, and so on to the first tank, in a direction counter to that of film travel. As the film advances through the wash, it enters cleaner and cleaner water.

A four-stage countercurrent final wash is illustrated in Figure 9-5.

Figure 9-5 Four-Stage Countercurrent Wash



OPERATING SPECIFICATIONS

Mechanical Specifications

The recommended mechanical specifications for Process ECP-2E are shown in Table 9-3 for persulfate bleach, Table 9-4 for ferricyanide bleach, and Table 9-5 for UL bleaches. Included are temperatures and tolerances, processing solution times, replenisher rates, and other pertinent information.

Use the processing times and drying conditions shown in the tables as a guide for preliminary machine design. The processing times actually used may differ slightly from the ones shown in the tables because of machine design variables, such as film velocity, degree of solution agitation, and amount of solution carry-over. You must determine those specifications necessary to produce satisfactory quality for your installation. Optimum drying conditions (air volume, temperature, and relative humidity) also vary with each dryer design.

Use the replenishment data listed with the mechanical specifications as a starting point for determining exact requirements to maintain the tank chemical analytical specifications.

Handle the exposed stock designated for Process ECP-2E under proper safelight conditions during machine loading and processing until after the stop. The processing steps after the stop can be performed in normal room light.

Table 9-3 Mechanical Specifications for Process ECP-2E with PERSULFATE Bleach

Process Steps	KODAK Formula		Temperature*		Time min:sec	Replenisher (Wash Rate) per 100 ft. (30.5 m) of 35 mm Film†	Recirculation (R); Filtration (F); Turbulation (T)
	Tank	Replenisher	°C	°F			
Developer‡	SD-50	SD-50Ra	36.7 ± 0.1	98.0 ± 0.2	3:00	690 mL	R, F§, & T¶ @125 to 175 L/min
Stop **	SB-14	SB-14	27 ± 1	80 ± 2	:40	770 mL	R & F @ 40 to 60 L/min
Wash	—	—	27 ± 3	80 ± 5	:40	1.2 L††	None
Accelerator ‡‡,**	AB-1b	AB-1bR	27 ± 1	80 ± 2	:20	200 mL	R & F @40 to 60 L/min
Persulfate Bleach ‡‡,**	SR-30	SR-30R	27 ± 1	80 ± 2	:40	200 mL	R & F§ @ 40 to 60 L/min
Wash	—	—	27 ± 3	80 ± 5	:40	1.2 L§§	None
Fixer	F-35b	F-35bR	27 ± 1	80 ± 2	:40	¶¶	R & F @ 40 to 60 L/min
Wash	—	—	27 ± 3	80 ± 5	1:00	1.2 L§§	None
Final Rinse ***	FR-2	FR-2R	27 ± 3	80 ± 5	:10	400 mL	R & F @ 40 to 60 L/min
Dryer	Type		Temperature		RH	Air Flow	Time
	Impingement		57°C (135°F)		15% to 25%	5000ft³/min	3 to 5 min.
	Nonimpingement		43° to 49°C (110° to 120°C)		15% to 25%	5000ft³/min	5 to 7 min.
Lubrication	35 mm 16 x 18 mm		Edgewax Full-coat lubrication				

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

† 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 and/or formulas 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.

‡ 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.

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

¶ Design developer racks with submerged rollers and rack-drive assemblies to minimize solution aeration and splashing.

** Install an exhaust over the stop tank, since developer carried over into the stop generates sulfur dioxide. Install an exhaust over the accelerator tank to eliminate odors. Install an exhaust over the persulfate bleach tanks to eliminate corrosion from chlorine vapors. The exhaust system should produce an air flow of 175 ft³/min (5 m³/min) for every square foot (0.09m²) of solution surface, and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank.

†† The stop wash rates given in this table assume the use of two-stage countercurrent washes with squeegees between stages. Single stage washes require substantially higher wash rates.

‡‡ Reconstitute and reuse persulfate bleach (SR-30) and accelerator (AB-1b), to obtain full economic advantage. See Module 5, *Chemical Recovery Procedures*, for procedures for reconstituting and regenerating persulfate bleach and accelerator.

§§ The wash rate given in this table assumes that the final wash and bleach wash are composed of three countercurrent-wash stages with squeegees between stages.The spray pressure and flow rate depend on machine speed and equipment used.

¶¶ Fixer replenisher requirements vary with silver recovery equipment, method, and operating conditions. If provision is made for continuous electrolytic desilvering for the recirculated fixer, the silver concentration should be maintained between 0.5 and 1 g/L. See Module 5, *Chemical Recovery Procedures*, for details. The fixer and replenisher must be kept separate from other processes. Savings from reconstituting desilvered fixer overflow for use as replenisher are possible.

*** Processing the print film does not require a formaldehyde stabilizer, therefore you may use Final Rinse, FR-2. FR-2 contains a wetting agent to promote more efficient squeegeeing of the film strand prior to drying. The Spectrus NX1106 or Proxel GXL reduces biological growth in the tank.

Table 9-4 Mechanical Specifications for Process ECP-2E with FERRICYANIDE Bleach

Process Steps	KODAK Formula		Temperature[*]		Time min:sec	Replenisher (Wash Rate) per 100 ft. (30.5 m) of 35 mm Film[†]	Recirculation (R); Filtration (F); Turbulation (T)
	Tank	Replenisher	°C	°F			
Developer[‡]	SD-50	SD-50Ra	36.7 ± 0.1	98.0 ± 0.2	3:00	690 mL	R, F[§], & T[¶] @ 125 to 175 L/min
Stop[**]	SB-14	SB-14	27 ± 1	80 ± 2	:40	770 mL	R & F @ 40 to 60 L/min
Wash[††]	—	—	27 ± 3	80 ± 5	:40	1.2 L[††]	None
Ferricyanide Bleach[‡‡]	SR-27	SR-27R	27 ± 1	80 ± 2	1:00	200 mL	R & F[§] @ 40 to 60 L/min
Wash[††]	—	—	27 ± 3	80 ± 5	:40	1.2 L[††]	None
Fixer	F-35d	F-35dR	27 ± 1	80 ± 2	:40	[§§]	R & F @ 40 to 60 L/min
Wash[††]	—	—	27 ± 3	80 ± 5	1:00	1.2 L[††, ¶¶]	None
Final Rinse[***]	FR-2	FR-2R	27 ± 3	80 ± 5	:10	400 mL	R & F @ 40 to 60 L/min
Dryer	**Type**		**Temperature**		**RH**	**Air Flow**	**Time**
	Impingement		57°C (135°F)		15% to 25%	5000ft^3/min	3 to 5 min.
	Nonimpingement		43° to 49°C (110° to 120°F)		15% to 25%	5000ft^3/min	5 to 7 min.
Lubrication	35 mm 16 x 18 mm		Edgewax Full-coat lubrication				

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

† 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 and/or formulas 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.

‡ 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.

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

¶ Design developer racks with submerged rollers and rack-drive assemblies to minimize solution aeration and splashing.

** Install an exhaust over the stop tank, since developer carried over into the stop generates sulfur dioxide. Install an exhaust over the bleach tanks to eliminate corrosion from vapors. The exhaust system should produce an air flow of 175 ft^3/min (5 m^3/min) for every square foot (0.09 m^2) of solution surface and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank.

†† The wash preceding the ferricyanide bleach must not become acid enough to lower the bleach pH below 6.0. Low pH in a ferricyanide bleach can promote the formation of Prussian blue. Keep the wash after the bleach effective enough to prevent film mottle from the reaction products of bleach carry-over into the fixer. Two-stage countercurrent washes with squeegees between stages is recommended for stop wash. The final wash and bleach wash rates assume the use of three-stage countercurrent washes with squeegees between stages. The wash rates given in the table assume the use of such staged washes. Single-stage washes require substantially greater wash rates.

‡‡ Reconstitute and reuse the bleach to obtain the full economic advantage. See Module 5, *Chemical Recovery Procedures*, for a procedure for regenerating Ferricyanide Bleach.

§§ Fixer replenisher requirements vary with silver recovery equipment, method, and operations conditions. If provision is made for continuous electrolytic desilvering for the recirculated fixer, the silver concentration should be maintained between 0.5 and 1 g/L. See Module 5, *Chemical Recovery Procedures*, for details. The fixer and replenisher must be kept separate from other processes. Savings from reconstituting desilvered fixer overflow for use as replenisher are possible.

¶¶ The wash rate given in this table assumes that the final wash is composed of three countercurrent-wash stages with squeegees between stages.

*** The final rinse contains a wetting agent to promote more efficient squeegeeing of the film strand prior to drying. The Proxel GXL or Spectrus NX1106 controls biological growth in the tank.

Table 9-5 Mechanical Specifications for Process ECP-2E with UL Bleach

Process Steps	KODAK Formula		Temperature[*]		Time min:sec	Replenisher (Wash Rate) per 100 ft. (30.5 m) of 35 mm Film[†]	Recirculation (R); Filtration (F); Turbulation (T)
	Tank	Replen-isher	°C	°F			
Developer[‡]	SD-50	SD-50Ra	36.7 ± 0.1	98.0 ± 0.2	3:00	690 mL	R, F[§], & T[¶] @ 125 to 175 L/min
Stop[**]	SB-14	SB-14	27 ± 1	80 ± 2	:40	770 mL	R & F @ 40 to 60 L/min
Wash[††]			27 ± 3	80 ± 5	:40	1.2 mL[††]	None
"UL" Bleach[‡‡]			27 ± 1	80 ± 2	1:00	400 mL	R & F[§] @ 40 to 60 L/min
Wash[††]	—	—	27 ± 3	80 ± 5	:40	1.2 L[††]	None
Fixer	F-35d	F-35dR	27 ± 1	80 ± 2	:40	[§§]	R & F @ 40 to 60 L/min
Wash[††]	—	—	27 ± 3	80 ± 5	1:00	1.2 L[††, ¶¶]	None
Final Rinse[***]	FR-2	FR-2R	27 ± 3	80 ± 5	:10	400 mL	R & F @40 to 60 L/ min
Dryer	**Type**		**Temperature**		**RH**	**Air Flow**	**Time**
	Impingement		57°C (135°F)		15% to 25%	5000ft^3/min	3 to 5 min.
	Nonimpingement		43° to 49°C (110° to 120°F)		15% to 25%	5000ft^3/min	5 to 7 min.
Lubrication	35 mm 16 x 18 mm		Edgewax Full-coat lubrication				

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

† 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 and/or formulas 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.

‡ 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.

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

¶ Design developer racks with submerged rollers and rack-drive assemblies to minimize solution aeration and splashing.

** Install an exhaust over the stop tank, since developer carried over into the stop generates sulfur dioxide. Install an exhaust over the bleach to remove vapors. The exhaust system should produce an air flow of 175 ft7.5/min (5 m^3/min) for every square foot (0.09 m^2) of solution surface and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank. The exhaust system should produce an air flow of 175 ft^3/min (5 m^3/min) for every square foot (0./09 m^2) of solution surface, and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank.

†† Keep the wash after the bleach effective enough to prevent film mottle from the reaction products of bleach carry-over into the fixer. Two-stage countercurrent washes with squeegees between stages is recommended for the stop wash. Three-stage washes are recommended for the bleach and final wash. The wash rates given in the table assume the use of such staged washes. Single-stage washes require substantially greater wash rates.

‡‡ Reconstitute and reuse the bleach to obtain the full economic advantage. See Module 5, *Chemical Recovery Procedures*, for a procedure for reconstituting and regenerating "UL" Bleach.

§§ Fixer replenisher requirements vary with silver recovery equipment, method, and operations conditions. If provision is made for continuous electrolytic desilvering for the recirculated fixer, the silver concentration should be maintained between 0.5 and 1 g/L. See Module 5, *Chemical Recovery Procedures*, for details. The fixer and replenisher must be kept separate from other processes. Savings from reconstituting desilvered fixer overflow for use as replenisher are possible.

¶¶ The wash rate given in this table assumes that the final wash is composed of three countercurrent-wash stages with squeegees between stages.

*** The final rinse contains a wetting agent to promote more efficient squeegeeing of the film strand prior to drying. The Proxel GXL or Spectrus NX1106 controls biological growth in the tank.

UL Bleach Formulations

Two UL Bleach formulations are available to fill various laboratory operating and environmental needs. They are:

- Ammonium UL or "UL House" Bleach. This formulation contains the highest percentage of ammonium ion which maximizes bleach activity. Because the least amount of active ingredients are necessary, this is the least expensive of the UL bleach varieties to operate. The use of ammonia in a laboratory may present some handling and odor considerations and is restricted in some sewer districts.

  The "UL House" Bleach formulation was derived to allow for a common tank and replenisher to be used for both Processes ECN and ECP. Its advantage is less mixing and solution handling between the two processes.
- Potassium "UL House" Bleach combines the advantages of a non-ammonium formulation with a house system where one replenisher feeds tanks for both Processes ECN and ECP. Through replenisher rate manipulation, the tanks for Processes ECN and ECP are maintained at appropriate levels so bleaching is completed while excess carryout is avoided.

Selecting a Bleach Formulation

Experimentation has shown that an all-ammonium bleach is the most active and, therefore, needs the minimum amount of iron (and the associated amount of PDTA) for adequate bleaching. When potassium cations are substituted for ammonium, more iron is needed to complete bleaching for the same time and temperature. The best formulation for use in a given lab should be determined based on several operating factors. Some of the factors to consider are:

- Local chemical cost and availability
- Laboratory ventilation factors
- Restrictions on sewer discharge

Controlling Bleach Tank Concentration with Replenisher Rate

Since bleach systems are subject to evaporation in the machine, overflow and replenisher holding tanks, system evaporation often plays a significant part in striking a balance between replenisher concentration, replenisher rate, and tank concentration. The best way to adjust between these factors, especially in a house system, is to vary the replenisher rate to maintain the desired tank concentration. Allowing the tank concentration to run high creates waste due to carryout. A low tank concentration presents the danger of inadequate bleaching. A new system should be started up using the suggested replenisher rates given for each bleach version. As the process or system seasons, the rates may be adjusted to give the desired tank concentrations. Bromide, iron, and pH are the critical parameters and should stay within limits given. If bromide or iron is too high, no harm to the process or film will occur, but expensive chemicals will be wasted due to carryout.

Conversion to UL Bleach

The advantages of converting to the UL bleach, from ferricyanide bleach (SR-27) are:

- UL bleach maintains a cleaner tank
- UL bleach forms no prussian blue
- UL bleach is easier to regenerate
- UL bleach regenerates into a cleaner replenisher

The advantages of converting to the UL bleach, from persulfate bleach are:

- UL bleach has more bleaching power
- UL bleach has a longer solution life
- UL bleach is less sensitive to process variations

Mechanical changes are minor; adjust controls to keep the bleach at 27°C (80°F). Solution times and replenishment rates do not change.

If using the ferricyanide bleach currently, first remove any red brass from the system, then clean up the bleach system. A high pH wash (10 to 12) will help eliminate any prussian blue in the system. Three cleaning cycles are recommended.

If persulfate bleach is now in your machine, a series of hot water rinses is needed in the accelerator and bleach tanks. The bleach and accelerator tanks should be filled with hot water and the recirculation and replenishment system turned on. Three to five cleaning cycles are recommended.

Chemical Supplies and Substitutions

Ferric nitrate is supplied in crystalline form as nonahydrate or dissolved in water as a 35 or 45% solution. Various bromides, carbonates, and hydroxides may be used interchangeably provided attention is given to effluent requirements and various molecular weights and activities are compensated. The following multipliers may be used to calculate between formulations:

- One gram of ferric nitrate nonahydrate = 1.31 mL of 35% = 0.93 mL of 45% solution
- One gram of ammonium bromide = 1.21 grams KBr = 1.05 grams NaBr
- One mL of 50% NaOH = 1.64 mL 45% KOH

If the odor or handling of acetic acid is a problem or undesirable, solid chemicals may be substituted. They are added as follows:

One mL of glacial acetic acid is equivalent to 1.05 grams of glacial acetic acid. One milliliter of glacial acetic acid can then be replaced by 1.35 grams of ammonium acetate. In potassium formulations, one mL of glacial acetic acid can be replaced with 1.71 grams of potassium acetate. The ammonium formulation is compensated by removing 2.2 mL of 28% ammonium hydroxide per mL of acetic acid from the formulation. The potassium formulation gets compensated by 1.49 mL of 45% potassium hydroxide for each mL of glacial acetic acid removed. This calculation is illustrated in the following example:

> Formula calls for 10 mL of glacial acetic acid and 30 mL of 28% ammonium hydroxide. Substituting for 10 mL of acetic: 10 mL x 1.35 grams ammonium acetate per gram acetic = 13.5 grams ammonium acetate. The amount of ammonium hydroxide to subtract is: 2.2 mL ammonium hydroxide per mL of acetic or 2.2 x 10 = 22 mL. The formula becomes zero acetic acid, 13.5 grams of ammonium acetate and 8 mL of ammonium hydroxide

Drying Specifications

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.

Adequate drying of color print film can be achieved in 3 to 5 minutes using an impingement dryer with the following specifications:

Hole diameter	6.4 mm (0.25 in)
Spacing between holes	57 mm (2.25 in.)
Film-to-plenum distance	21 mm (0.81 in.)

Specifications for the dryer input air are in Tables 9-3, 9-4, and 9-5. A nonimpingement dryer can be used if the drying time is increased to 5 to 7 minutes and the air going into the dryer is maintained at the specifications in Tables 9-3, 9-4, or 9-5.

Upon cooling to room temperature after leaving the dryer, the film should have a moisture content at equilibrium with air at 50 percent relative humidity.

Turbulation Specifications

Turbulators are essential in the recirculation system for Process ECP-2E developer to provide uniform film processing. The turbulators are 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.

The requirements for solution turbulation are dependent on film transport speed. Machines with lower speeds will require more turbulation than faster machines. Good process uniformity can be achieved at a film speed of 165 ft/min (50 m/min) using the design guidelines in Module 2, *Equipment and Procedures*, Table 2-2, *Developer Turbulation Design Guidelines, Process ECN-2, ECP-2E, D-96 and D-97*. Precise turbulation design must be determined specifically for a particular processing machine to provide for good uniformity of development. The guidelines in Module 2 give helpful starting points for such designs. Backup rollers opposite the turbulators may be necessary depending on strand tension, strand length, film format, and nozzle pressure.

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: (1) using multi-stage countercurrent-flow washes, (2) installing squeegees between wash stages as well as before the wash, and (3) 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 saving from the use of squeegees and countercurrent stages can be substantial. A three-stage countercurrent 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. See Module 2, *Equipment and Procedures*, for information on control of 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 Tables 9-3, 9-4, or 9-5.

The wash-water flow rates in Tables 9-3, 9-4, and 9-5 have been found to be satisfactory in a 165 ft/min (50 m/min) processor, using three-stage countercurrent bleach and final washes with efficient squeegees between stages. The other washes employ the use of two-stage countercurrent washes. The optimum wash rates for a particular installation can be determined only after the film transport rate, the number of countercurrent stages, and the squeegee efficiencies have been established. Experimentation is necessary to determine minimum wash-water flow rates that will provide adequate washing. Inadequate washing will result in significant contamination of the solution after the wash with the solution before the wash.

Stop Wash

An inadequate wash will result in a high level of Color Developing Agent CD-2 in the bleach or bleach accelerator.

Bleach Wash

If using the alternate cycle with ferricyanide bleach, an inefficient bleach will cause excessive buildup of bleach-fixer reaction products in the fixer. The combined levels of potassium ferricyanide and sodium ferrocyanide in the final stage of the bleach wash should be below 0.5 g/L, as measured by Analytical Methods *ECP-00021/1* and *ECP-2E-1101* (or *ECP-0023/01*) in Module 3, *Analytical Procedures*.

Final Wash

The final wash must remove most of the thiosulfate (hypo) from the film. Retained hypo levels of 4 µg/cm2 or greater can cause serious dye fading. If the recommended three-stage countercurrent wash and wash rate are used, residual hypo in the designated films processed in Process ECP-2E should be barely detectable (0.2 to 0.4 µg/cm2) by Analytical Method *ULM-0004/1* in Module 3, *Analytical Procedures.*

Rewashing

For many years, the term rewashing referred to the common practice of running processed film through a complete process for a second time. This operation removes dirt and/or heals slight emulsion scratches and digs. Rewashing a film once in the original process produces minimal changes in the dye stability and sensitometry. However, several rewashings may cause a change in density over the exposure scale of the film. By omitting the developer and bleach when the film is rewashed, changes in density can be minimized.

Rewash RW-1 is designed to avoid these sensitometric and dye stability changes, and at the same time, to produce similar emulsion swells to that obtained by going through the original developer.

Table 9-6 Rewash RW-1 Sequence

Step	Function
1. Prebath PB-6	Swells the emulsion, causing the scratches to be filled in and embedded dirt particles to be released.
2. Wash	Removes unwanted chemicals, which, if left in, affect dye stability.
3. Final Rinse FR-1	Contains a wetting agent to help prevent water spots while the film is being dried.
4. Dry	Dries film for subsequent handling.

The rewash machine consists of a loading elevator, tanks for the prebath, wash, and final rinse solutions, and a dryer. Submerged rollers and rack-drive assemblies will minimize spattering of solutions and aerial oxidation of sulfite in the prebath. Type 316 stainless steel is suitable for tanks, racks, and recirculation equipment. Use 10-micron filters of polypropylene, fiberglass, or bleached cotton in the recirculation system. Use no squeegees, except after the final rinse, where a high efficiency final squeegee is needed.

Table 9-7 Mechanical Specifications for Rewash RW-1

Process Steps	KODAK Formula	Temperature*		Time	Replenisher (Wash Rate) per 100 ft. (30.5 m) of 35 mm Film†	Recirculation (R); Filtration (F)
	Tank and Replenisher	°C	°F	min:sec		
Prebath	PB-6	21 ± 1	70 ± 2	2:00	600 mL	R & F @ 20 to 40 L/min
Wash	—	21 to 38	70 to100	3:00	300 mL‡	None
Final Rinse	FR-1	21 to 38	70 to100	:10	400 mL	R & F @ 20 to 40 L/min

* Fahrenheit temperatures are primary. Celsius temperatures are rounded consistent with process-control requirements.
† For 16 mm film, use one-half the 35 mm film replenishment and wash rates.
‡ Use a two-stage countercurrent wash.

PROCESSING CHEMICALS AND FORMULAS

Packaged Chemicals

Kodak packaged chemical kits are available for the solutions used in Process ECP-2E. Solutions may also be prepared according to the *Formulas and Analytical Specifications*, using chemicals purchased in bulk.

Bulk Chemicals

The list of suppliers below is not intended to be all-inclusive, nor are the suppliers listed in any order of preference. The mention of a supplier is not intended as a recommendation by Eastman Kodak Company. Most of the chemicals listed are available from local chemical supply houses. For additional suppliers, consult *Chemical Week*, *Chemical Buyers*, or *Thomas' Register* in public libraries.

Information on the known hazards and safe handling of the following chemicals is available from the supplier of the chemical in the form of chemical container labels and Material Safety Data Sheets (MSDS) as required by the OSHA Hazard Communication Standard Act and many state laws.

Table 9-8 SUPPLIERS OF PROCESSING CHEMICALS

Chemical or Trade Name	Formula or Chemical Name	Some Suppliers	Supplier Phone Number
Acetic Acid, Glacial	CH_3COOH	Fisher Scientific	800-766-7000
		Brown Chemical Company	201-337-0900
Ammonium Bromide	NH_4Br	Ameribrome, Inc.	212-286-4000
		Pechiney World Trade USA	800-736-7893
Ammonium Hydroxide (28% Solution)	NH_4OH	Fisher Scientific	800-766-7000
		Mallinckodt, Inc.	800-554-5343
		Van Waters and Rogers	425-889-3400
Ammonium Thiosulfate	$(NH_4)_2S_2O_3$	Fisher Scientific	800-766-7000
		General Chemical Company	973-515-0900
		E.I. du Pont de Nemours & Company, Inc.	800-441-7515
KODAK Anti-Calcium, No. 4	—	Eastman Kodak Company	800-621-3456
Beta-Aminopropionic Acid (Beta-Alanine)	—	Allan Chemical Company	201-592-8122
		Chemical Dynamics Corporation	908-753-5000
KODAK Chelating Agent, No. 1	—	Eastman Kodak Company	800-621-3456
KODAK Color Developing Agent, CD-2	—	Eastman Kodak Company	800-621-3456
Ethylene-diamine*	$NH_2CH_2CH_2NH_2$	Fisher Scientific	800-766-7000
		Ashland Chemical Company	614-790-3333
		Union Carbide Corporation	800-568-4000
		Dow Chemical USA	800-447-4369
(Ethylene-dinitrilo) Tetraacetic Acid, Tetrasodium Salt	—	Dow Chemical USA	800-447-4369
		BASF Corporation	973-426-2800
		Fisher Scientific	800-766-7000
Ferric Nitrate Nonahydrate*	$Fe(NO_3)_3 \bullet 9H_2O$	Mallinckodt, Inc.	800-554-5343
		Shepherd Chemical Company	513-731-1110
		General Chemical Company	973-515-0900
Gelatin	—	American Gelatin Company	781-933-2800
KODAK Persulfate Bleach Accelerator PBA-1	—	Eastman Kodak Company	800-621-3456
Phosphoric Acid*	H_3PO_4	Fisher Scientific	800-766-7000
		Ashland Chemical Company	614-790-3333
		Brown Chemical Company, Inc.	201-337-0900
Potassium Ferricyanide, Anhydrous*	$K_3Fe(CN)_6$	Ashland Chemical Company	516-627-6000
Potassium Iodide*	KI	Anachemia Chemicals, Inc.	800-323-1414
		Mallinckrodt, Inc.	800-554-5343
Potassium Persulfate*	$K_2S_2O_8$	Fisher Scientific	800-766-7000
		FMC Corporation	800-323-7107
		Brown Chemical Company, Inc.	201-337-0900
Proxel GXL	—	Avecia, Inc.	800-523-7391
Sodium Bisulfite, Anhydrous*	$NaHSO_3$	Ashland Chemical Company	614-790-3333
		Fisher Scientific	800-766-7000
		Brown Chemical Company, Inc.	201-337-0900
Sodium Bromide, Anhydrous*	NaBr	Brown Chemical Company	201-337-0900
Sodium Carbonate, Anhydrous*	NA_2CO_3	Brown Chemical Company, Inc.	201-337-0900
		Ashland Chemical Company	614-790-3333
Sodium Chloride*	NaCI	Ashland Chemical Company	614-790-3333
		Mallinckodt, Inc.	800-554-5343
		American International Chemical Company	508-655-5805

Chemical or Trade Name	Formula or Chemical Name	Some Suppliers	Supplier Phone Number
Sodium Phosphate, Monobasic, Anhydrous*	NaH_2PO_4	Pechiney World Trade USA	800-736-7893
		Degussa-Huls Corporation	201-641-6100
Sodium Ferrocyanide, Decahydrate*	$Na_4Fe(CN)_6$•$10H_2O$	Degussa-Huls Corporation	201-641-6100
		Filo Chemical, Inc.	212-514-9330
Sodium Hydroxide*	NaOH	Ashland Chemical Company	614-790-3333
		Brown Chemical Company	201-337-0900
		Dow Chemical USA	800-447-4369
		Fisher Scientific	800-766-7000
Sodium Hypochlorite	NaOCI	Ashland Chemical Company	614-790-3333
		Brown Chemical Company	201-337-0900
		Delta Chemical Company	410-354-0100
Sodium Metabisulfite Anhydrous*	$Na_2S_2O_5$	Fisher Scientific	800-766-7000
		BASF Corporation	800-426-8702
		American International Chemical Company	508-655-5805
Sodium Persulfate*	$Na_2S_2O_8$	Fisher Scientific	800-766-7000
		FMC Corporation	800-323-7107
		Brown Chemical Company, Inc.	201-337-0900
Sodium Sulfate, Anhydrous*	Na_2SO_4	General Chemical Corporation	973-515-0900
		Fisher Scientific	800-766-7000
		American International Chemical Company	508-655-5805
Sodium Sulfite, Anhydrous*	Na_2SO_3	Ashland Chemical Company	614-790-3333
		Fisher Scientific	800-766-7000
Spectrus NX1106	—	Betz Dearborn Inc.	215-355-3300
KODAK Stabilizer Additive	—	Eastman Kodak Company	800-621-3456
Sulfuric Acid, Concentrated*	H_2SO_4	Ashland Chemical Company	614-790-3333
		Fisher Scientific	800-766-7000
		E.I. du Pont de Nemours & Company, Inc.	800-441-7515

* These chemicals must meet the ANSI/ACS specifications. An index of all ANSI specifications is available from American National Standards Institute, 550 Mamaronek Ave., Harrison, New York 10528.

Solution Mixing

1. Use the following mixing practices when preparing processing solutions with common mixing equipment. Mix solutions in the order in which the solutions occur in the process sequence. This order will minimize mixing time and oxidation, while providing consistent results. See Module 10, *Effects of Mechanical & Chemical Variations in Process ECP-2E*, for sensitometric effects of contamination and solution concentration errors.

The mixing area should be well ventilated and have a local exhaust over the mixing tank to carry off fumes and chemical dust. See Module 2, *Equipment and Procedures*, for exhaust specifications.

Good mixing practices:

1. Observe all precautionary information on containers and packages of each chemical, and on the Material Safety Data Sheets available from the seller of the individual chemical. Footnotes with some formulas provide further precautionary information.
2. Rinse the mix tank with water, and run fresh water through the pump. Drain the tank and pump.
3. Fill the tank to the mixing level with water at the appropriate temperature, and start the mixer. Be sure the mixer is large enough to provide adequate agitation for the volume of solution desired. The starting mixing level should be 80 percent of the final volume (if a water hopper is used, take care not to over dilute the solution). Allow one minute for agitating the water between the time the mixer is started and the first chemical addition is made. This action helps remove air from the water and disperse the first chemical addition.
4. Premeasure all chemicals,* but do not combine the dry chemicals together before adding them to the mixing tank. This practice can result in unwanted chemical reactions producing toxic and noxious fumes. The formula for each processing solution lists chemicals in the proper mixing order. Add and dissolve the chemicals in the order given, and dilute the solution to volume with water. When mixing sound track developer accelerator for persulfate bleach, ferricyanide bleach, and UL bleaches, observe the following special mixing instructions.

   PERSULFATE BLEACH ACCELERATOR: Mixing with high agitation for extended periods of time can result in the loss of some PBA-1 due to aerial oxidation. Mix only until all solid chemicals have dissolved.

   FERRICYANIDE BLEACH: When the ferricyanide bleach is made with ferrocyanide and persulfate, the solution should be allowed to sit approximately an hour before final adjustments are made. This allows for complete reaction of the two chemicals.

   Caution

   CORROSIVE: Avoid contact with solution and vapor. Avoid breathing vapor. Wear safety goggles and impervious gloves. Store in a cool place to prevent pressure build-up in the container.

   UL BLEACH: When adding Ammonium Hydroxide to the mix tank, be sure to add it below, or at the surface of the solution to minimize the escape of Ammonia vapor. Careless handling may require evacuation of the mix room.

5. Agitate the solution for a few minutes after it has been diluted to volume, to promote complete and uniform dissolution of all the constituents. The prebath, developer, stop, and final rinse should be agitated for at least 5 minutes after dilution to volume; the fixer for 10 minutes; and the bleach for 15 minutes.
6. Analyze the solution for its critical constituents after mixing. Then place the certified solution into the appropriate storage tank.
7. Carefully rinse the mixing tank and any pump used to transport the solution. Clean the mixing equipment immediately after the tank is emptied, before salts and tars have time to form. The tank is more efficiently rinsed with numerous small-volume rinses than with fewer large-volume rinses.

* When preparing processing solutions, use photographic grade chemicals (passing the ANSI or ANSI/ACS specifications). Kodak, as well as some other suppliers, provide such chemicals.

Formulas and Analytical Specifications

Maintain the fresh tank formula specifications exactly as given on the following pages. Any large deviations from tank specifications, noted by chemical analysis, should be corrected immediately by appropriate additions or cuts to the tank solution. Any long-term tendency to deviate from the tank analytical specifications (e.g., slowly increasing pH) should be corrected by adjustment of the replenisher. The replenisher formula specifications are to be used as starting points for typical operations.

Important

Observe precautionary information on product labels and on the Material Safety Data Sheets.

Developer

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Developer	**(SD-50)**			
Water 24-38°C (75-100°F)	900 mL		900 mL	
KODAK Anti-Calcium, No. 4	1.0 mL		1.4 mL	
Sodium Sulfite (Anhydrous)*	4.35 g	4.00 ± 0.25 g/L	4.50 g	4.20 ± 0.25 g/L
KODAK Color Developing Agent CD-2*	2.95 g	2.70 ± 0.25 g/L	5.80 g	5.70 ± 0.25 g/L
Sodium Carbonate (Anhydrous)	17.1 g		18.0 g	
Sodium Bromide (Anhydrous)	1.72 g	1.72 ± 0.10 g/L	1.60 g	1.60 ± 0.10 g/L
Sodium Hydroxide	None		0.90 g	
Sulfuric Acid (7.0 N)	0.62 mL		None	
Water to make	1000 mL		1000 mL	
pH at 25.0°C (77.0°F)		10.59 ± 0.05		11.20 ± 0.05
Specific Gravity at 25.0°C (77.0°F)		1.025 ± 0.003†		1.023 ± 0.003
Total Alkalinity (10 mL sample)		35.0 ± 2 mL		39.0 ± 2 mL
WARNING! May cause eye and skin irritation and allergic skin reaction. Avoid contact with eyes, skin, and clothing.				

* The difference between the mix levels and the analytical specifications for CD-2 and sodium sulfite are to compensate for aeration losses that occur during mixing and transfer of solution to the machine tank. The mix levels necessary to achieve the required analytical specifications will vary with mixing equipment and solution transfer techniques.

† Developer specific gravity will rise from 1.020 ± 0.003 to 1.025 ± 0.003 as the developer is seasoned.

To process VISION Premier Color Print Film, the normal replenisher flow rate must be increased by 8%. If the footage processed is less than one tank turnover, no change of pH is required in the replenisher, but small adjustment could be necessary in the tank processor. For larger quantity of VISION Premier Color Print Film (more than one tank turnover), it is recommended to increase the replenisher pH to 11.45.

Alternate Developer

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Developer	**(SD-51)**			
Water 24-38°C (75-100°F)	900 mL		900 mL	
(Ethylenedinitrilo) Tetraacetic Acid Tetrasodium Salt	4.0 g		4.8 g	
EASTMAN Developer Stabilizer No. 1*	0.20 g		0.25 g	
Sodium Sulfite (Anhydrous)†	4.35 g	4.00 ± 0.25 g/L	4.50 g	4.20 ± 0.25 g/L
KODAK Color Developing Agent CD-2†	2.95 g	2.70 ± 0.25 g/L	5.80 g	5.70 ± 0.25 g/L
Sodium Carbonate (Anhydrous)	17.1 g		18.0 g	
Sodium Bromide (Anhydrous)	1.72 g	1.72 ± 0.10 g/L	1.60 g	1.60 ± 0.10 g/L
Sodium Hydroxide	None		0.90 g	
Sulfuric Acid (7.0 N)	0.62 mL		None	
Water to make	1000 mL		1000 mL	
pH at 25.0°C (77.0°F)		10.59 ± 0.05		11.20 ± 0.05
Specific Gravity at 25.0°C (77.0°F)		1.020 ± 0.003‡		1.023 ± 0.003
Total Alkalinity (10 mL sample)		35.0 ± 2 mL		39.0 ± 2 mL
WARNING! May cause eye and skin irritation and allergic skin reaction. Avoid contact with eyes, skin, and clothing.				

* EASTMAN Developer Stabilizer, No. 1 (DS-1) is also known as Chemical No. 10040097 and is available from Kodak by calling (716) 722-5545 or Faxing a P.O. to (716) 722-2175.

† The differences between the mix levels and the analytical specifications for CD-2 and sodium sulfite are to compensate for aeration losses that occur during mixing and transfer of solution to the machine tank. The mix levels necessary to achieve the required analytical specification will vary with mixing equipment and solution transfer techniques.

‡ Developer specific gravity will rise from 1.020 ± 0.003 to 1.025 to ± 0.003 as the developer is seasoned.

To process VISION Premier Color Print Film, the normal replenisher flow rate must be increased by 8%. If the footage processed is less than one tank turnover, no change of pH is required in the replenisher, but small adjustment could be necessary in the tank processor. For larger quantity of VISION Premier Color Print Film (more than one tank turnover), it is recommended to increase the replenisher pH to 11.45.

Stop

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Stop	**(SB-14)**			
Water 21-38°C (70-100°F)	900 mL		Same as Tank	
Sulfuric Acid (7.0 N)	50 mL*			
Water to make	1 L			
pH at 25.0°C (77.0°F)		0.8 to 1.5		
WARNING! May cause burns of skin and eyes. Avoid contact with eyes, skin, and clothing. In case of contact, immediately flush eyes and skin with plenty of water; for eyes, get medical attention.				

* 10 mL of concentrated sulfuric acid may be substituted.

Accelerator

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Accelerator *	**(AB-1b)**		**(AB-1bR)**	
Water 24- 38°C (75-100°F)	900 mL		900 mL	
Sodium Metabisulfite (Anhydrous)	3.3 g	2.0 ± 0.5 g/L†	5.6 g	3.3 ± 0.5 g/L†
Acetic Acid (Glacial)	5.0 mL	5.0 ± 0.5 mL/L‡	7.0 mL/L	7.0 ± 0.5 m/L‡
Persulfate Bleach Accelerator PBA-1 or KODAK liquid PBA-1§	3.3 g or 4.0 mL	3.3 ± 0.3 g/L or 4.0 ± 0.4 mL/L	4.9 g or 5.9 mL	4.9 ± 0.3 g/L or 5.9 ± 0.4 mL/L
(Ethylenedinitrilo) Tetraacetic Acid Tetrasodium Salt	0.5 g		0.7 g	
Water to make	1 L		1 L	
pH at 25.0°C (77.0°F)		4.0 ± 0.2		3. ± 0.2
Specific Gravity at 25.0°C (77.0°F)		1.007 ± 0.003 1.031 ± 0.003 (seasoned)		1.012 ± 0.003

* Mixing the accelerator with high agitation for extended periods of time results in loss of some PBA-1 due to aerial oxidation. Mix the accelerator only until all chemicals are dissolved.

† The analytical method measures the total sulfite content of the solution and reports it as sodium metabisulfite ($Na_2S_2O_5$). If a solution addition to the sodium metabisulfite level must be made but sodium bisulfite is to be used, multiply the sodium metabisulfite addition weight by the factor 1.09 to obtain the equivalent amount of sodium bisulfite.
The difference between mix level and the analytical specification occurs because some sulfite is consumed in a reaction with KODAK Persulfate Bleach Accelerator PBA-1 to form the active accelerator species "in situ."

‡ The analytical method measures buffer capacity and results are reported in terms of glacial acetic acid. Adjustment in pH should be made with glacial acetic acid or 50% sodium hydroxide.

§ For convenience, add PBA-1 from a 250 g/L stock solution. Prepare by dissolving 5 kg PBA-1 in water and diluting to 20 L. Each 4 mL of stock solution contains 1 g PBA-1. For a 100 L replenisher of AB-1bR, add 1.96 L of stock solution.

To process VISION Premier Color Print Film, the accelerator replenisher flow rate may need to be increased. If only a small amount of footage is processed no change in the flow rate should be required in the replenisher. For larger quantities of VISION Premier Color Print Film (more than one tank turnover), it is recommended to increase the flow rate by approximately 20% and closely monitor the PBA-1 level and retained silver in the D-max area of the film.

Bleach

Persulfate Bleach

Only to be used in combination with accelerator solution.

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Persulfate Bleach	**(SR-30)**		**(SR-30R)**	
Water 24-38°C (75-100°F)	850 mL		800 mL	
Chlorine Scavenger *	0.35 g		0.50 g	
Sodium Persulfate	33 g	30 ± 2 g/L	52 g	48 ± 3 g/L
Sodium Chloride	15 g	15 ± 3 g/L	20 g	20 ± 2 g/L
Sodium Dihydrogen Phosphate (Anhydrous)	7.0 g		10.0 g	
Phosphoric Acid (85%)	2.5 mL	7.0 ± 1.0 mL/L†	2.5 mL	8.8 ± 1.0 mL/L†
Water to make	1 L		1 L	
pH at 25.0°C (77.0°F)		2.3 ± 0.2		2.4 ± 0.2
Specific Gravity at 25.0°C (77.0°F)		1.037 ± 0.003 (fresh) 1.085 (seasoned)‡		1.059 ± 0.003

* Since there are many acceptable chlorine scavengers, convenience of use and cost may be factors in making a choice. Hydrolysate, a soluble version of gelatin, is available from U.S. Gelatin Corporation. Both food and photographic-grade gelatin have been used successfully. The gelatin must first be dissolved in 40°C (104°F) water and stirred for 20 minutes. Up to 50 g/L can be added in this way in order to make a stock solution for subsequent use. Beta-aminopropionic acid is higher cost alternative offering easy solubility.

† The analytical method measures the buffer capacity of the bleach and reports the result as mL/L of phosphoric acid (85%). The analytical specification (7.0 mL) is larger than the amount of phosphoric acid added (2.5 mL) because dihydrogen phosphate (and sulfate in seasoned solutions) also contributes to the measurement. If a correction must be made, phosphoric acid (85%) can be added on a mL-for-mL basis. For example, if the tank analysis reports 5.0 mL/L, then the correction would be to add 2.0 mL/L of phosphoric acid (85%).

‡ If the bleach tank overflow is being reused, the specific gravity (a measure of sulfate ion buildup) should not exceed this value as incomplete bleaching could occur.

Alternate Process Bleaches

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
UL Bleach* or "UL House" Bleach*				
Water 21-38°C (70-100°F)	700 mL		700 mL	
Proxel GXL	0.07 mL		0.10 mL	
Ammonium Hydroxide Solution (28%)†	54 mL		64 mL	
KODAK Chelating Agent No. 1 (PDTA)	44.8 g		51 g	
Ammonium Bromide (NH_4Br) or Sodium Bromide (NaBr)	23.8 or 25 g	23.8 or 25 ± 3 g/L	30.7 or 32.3 g	30.7 or 32.3 ± 3 g/L
Acetic Acid Solution (90%)	10 mL		14.5 mL	
Ferric Nitrate (Nonahydrate)‡	53.8 g		61.2 g	
Water to make	1 L		1 L	
pH at 25.0°C (77.0°F)§		5.30 ± 0.20		5.30 ± 0.20
Specific Gravity at 25.0°C (77.0°F)		1.056 ± 0.003		1.066 ± 0.003
Total Iron		7.50 ± 0.50 g/L		8.20 ± 0.50 g/L
Ferric Iron		7.50 ± 0.50 g/L		8.20 ± 0.50 g/L
Ferrous Iron		<0.5 g/L		<0.5 g/L

* This formulation for bleach replenisher and tank can also be used as a "house" bleach for Process ECN and Process ECP. The rate of replenishment would be adjusted for each process to arrive at the appropriate tank concentrations for each constituent. The starting point replenishment rate recommendations for Process ECN and Process ECP are 200 mL/L and 400 mL/L respectively.

† You can substitute ammonium acetate for ammonium hydroxide and acetic acid. See *Chemical Supplies and Substitutions* .

‡ When using 35% solution by weight, use 70.5 g/L in Tank, and 80.2 g/L in Replenisher.

§ Adjust pH using glacial acetic acid, 7.0 N sulfuric acid, or 20% ammonium hydroxide.

Note:

- It is especially important to follow the *Good mixing practices:* when preparing this bleach.
- Follow exactly the mix order given above.
- Check the solution pH before starting the ferric nitrate addition. It should be between 8 and 8.5; adjust if necessary.
- Add the ferric nitrate solution slowly while mixing.
- The solution should be clear and yellow after completion of the ferric nitrate addition and subsequent mixing. A temporarily cloudy solution caused by too low a pH will clear during pH adjustment.
- A solution which stays red for a long time after mixing indicates an excess of iron or deficiency of chelating agent.
- A pH correction can be made using sulfuric acid or ammonium hydroxide. Do not use phosphoric acid or strong bases such as potassium or sodium hydroxide.
- When processing more than one tank turnover of VISION Premier Color Print Film, be sure to monitor the retained silver in the image area D-max.

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Potassium “UL” Bleach				
Water 21-38°C (70-100°F)	700 mL		700 mL	
Proxel GXL	0.07 mL		0.07 mL	
KOH (45%)*			84 mL	
KODAK Chelating Agent No. 1 (PDTA)	54 g		60 g	
KBr or NaBr	92 g or 78 g	92 g or 78 g	101 g or 86 g	101 g or 86 g
Acetic Acid	13.5 mL		15 mL	
Ferric Nitrate (Nonahydrate)†	63 g		70 g	
Water to make	1 L		1 L	
pH at 25.0°C (77.0°F)		5.30 ± 0.20		5.30 ± 0.20
Specific Gravity at 25.0°C (77.0°F)‡		1.131 ± 0.003		1.142 ± 0.003
Total Iron		9.0 ± 0.5 g/L		10 ± 0.5 g/L
Ferric Iron		9.0 ± 0.5 g/L		10 ± 0.5 g/L
Ferrous Iron		<0.5 g/L		<0.5 g/L

* DO NOT add more potassium hydroxide after ferric nitrate is added.
† See *Chemical Supplies and Substitutions* for possible chemical alternatives.
‡ Adjust pH with glacial acetic acid, potassium carbonate, or 7.0 N sulfuric acid.

Note: See *Chemical Supplies and Substitutions* for calculations regarding raw chemical concentrations and alternatives.

- It is especially important to follow the *Good mixing practices:* when preparing this bleach.
- Follow exactly the mix order given above.
- Check the solution pH before starting the ferric nitrate addition. It should be between 8 and 8.5; adjust if necessary.
- Add the ferric nitrate solution slowly while mixing.
- The solution should be clear and yellow after completion of the ferric nitrate addition and subsequent mixing. A temporary cloudy solution caused by too low a pH will clear during pH adjustment.
- A solution which stays red for a long time after mixing indicates an excess of iron or a deficiency of chelating agent.
- A pH correction can be made using sulfuric acid or potassium carbonate. Do not use phosphoric acid or strong bases such as potassium or sodium hydroxide after ferric nitrate addition.
- When processing more than one tank turnover of VISION Premier Color Print Film, be sure to monitor the retained silver in the image area D-max.

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Ferricyanide Bleach	**(SR-27)**		**(SR-27R)**	
Water 32-43°C (90-110°F)	900 mL		900 mL	
Potassium Ferricyanide (Anhydrous) *	30.0 g	30.0 ± 5.0 g/L	49.0 g	49.0 ± 2.0 g/L
Sodium Bromide (Anhydrous)	17.0 g	17.0 ± 2.0 g/L	26.0 g	26.0 ± 2.0 g/L
Water to make	1 L		1 L	
pH at 25.0°C (77.0°F)†		6.5 ± 0.5		8.0 ± 0.3
Specific Gravity at 25.0°C (77.0°F)		1.027 ± 0.003 (fresh)		1.043 ± 0.003

* One gram of this compound can also be obtained by mixing 0.41 gram of potassium persulfate and 1.47 grams of sodium ferrocyanide decahydrate. The reaction between potassium persulfate and sodium ferrocyanide takes about 1 hour, after which the final adjustments to the mix should be made.
† Adjust to proper pH with 2.5 N sodium hydroxide of 2.5 N sulfuric acid.

- When processing more than one tank turnover of VISION Premier Color Print Film, be sure to monitor the retained silver in the image area D-max.

Fixer

To be used with persulfate bleach (may also be used with alternate process bleaches)

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Fixer	**(F-35b)**		**(F-35-bR)**	
Water 21-38°C (70-100°F)	800 mL		700 mL	
Ammonium Thiosulfate Solution (58%)	100 mL	100 ± 10 mL/L	170.0 mL	170 ± 10 mL/L
Sodium Sulfite (Anhydrous)	2.5 gL	15.0 ± 3.0 g/L*	16.0 g	23.0 ± 3.0 g/L*
Sodium Bisulfite (Anhydrous)	10.3 g		5.8 g	
Potassium Iodide	0.50 g	0.50 ± 0.02 g/L	0.70 g	0.70 ± 0.02 g/L
Water to make	1 L		1 L	
pH at 25.0°C (77.0°F)		5.8 ± 0.2†		6.6 ± 0.2†
Specific Gravity 25.0°C (77.0°F)		1.060 ± 0.003 (fresh)		1.083 ± 0.003
Hypo Index (3 mL sample)		24.0 ± 2.0		38.0 ± 2.0

* Test method (using 3 mL sample) measures sulfite and bisulfite together as total sulfite (Na_2SO_3).

† Fixer pH may decrease with certain operating conditions when electrolytically desilvering the fixer. If the fixer is not desilvered or desilvered by the batch method, the replenisher pH should be 5.00 ± 0.015. Care should be taken to avoid fixer pH lower than 4.5 since lower fixer pH could cause sulfurization of the fixer.

To process a large quantity (more than one tank turnover) of VISION Premier Color Print Film, the normal replenishment flow rate of the fix may need to be increased by up to 30%.

Alternate Process Fixer

(can be used with alternate process bleaches, not persulfate)

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Fixer	**(F-35d)**		**(F-35dR)**	
Water 21-38°C (70 to 100°F)	800 mL		700 mL	
Ammonium Thiosulfate Solution (58%)	100 mL	100 mL ± 10 mL/L	170.0 mL	170 mL ± 10 mL/L
Sodium Sulfite (Anhydrous)	None	15.0 ± 3.0 g/L	2.5 g	20.5 ± 3.0 g/L*
Sodium Bisulfite (Anhydrous)	13.0 g		17.5 g	
Sulfuric Acid (7.0 N)	2.7 mL		None	
Water to make	1 L		1 L	
pH at 25.0°C (77.0°F)		5.00 ± 0.15†		5.80 ± 0.15†
Specific Gravity at 25.0°C (77.0°F)		1.060 ± 0.003 (fresh)		1.083 ± 0.003
Hypo Index (3 mL sample)		24.0 ± 2.0		38.0 ± 2.0

* Test method (using 3 mL sample) measures sulfite and bisulfite together as total sulfite (Na_2SO_3).

† Fixer pH may decrease with certain operating conditions when electrolytically desilvering the fixer. If the fixer is not desilvered or is desilvered by the batch method, the replenisher pH should be 5.00 ± 0.15. Care should be taken to avoid fixer pH lower than 4.5 since lower fixer pH could cause sulfurization of the fixer.

To process a large quantity (more than one tank turnover) of VISION Premier Color Print Film, the normal replenishment flow rate of the fix may need to be increased by up to 30%.

Alternate Process Fixer

The Sodium Fixer is recommended as an alternate fixer for use only with a persulfate bleach. The sodium fixer is not recommended for use in the ECN-2 process or as a "House Fixer".

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Sodium Fixer				
Water 21-38°C (70 to 100°F)	800 mL		800 mL	
Sodium Thiosulfate (Anhydrous)	82.7 g	82.7 g ± 8 g/L	141 g	141 g ± 8 g/L
Sodium Sulfite	2.5 g	15 g	19 g	27 g*
Sodium Bisulfite	10.3 g		6.5 g	
Potassium Iodide	0.5 g		0.7 g	
Water to make	1 L		1 L	
pH at 25.0°C (77.0°F)		5.8 ± 0.20,†		6.6 ± 0.20†
Specific Gravity at 25.0°C (77.0°F)		1.091		1.088

* Test method (using 3 mL sample) measures sulfite and bisulfite together as total sulfite (Na_2SO_3).

† Fixer pH may decrease with certain operating conditions when electrolytically desilvering the fixer. If the fixer is not desilvered or is desilvered by the batch method, the replenisher pH should be 5.00 ± 0.15. Care should be taken to avoid fixer pH lower than 4.5 since lower fixer pH could cause sulfurization of the fixer. At a higher pH than designated, stain can occur because all the developing agent may not be removed from the film before the bleaching step.

To process a large quantity (more than one tank turnover) of VISION Premier Color Print Film, the normal replenishment flow rate of the fix may need to be increased by up to 30%.

Final Rinse

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Final Rinse*	**(FR-2)**		**(FR-2R)**	
Water 21-38°C (70-100°F)	900 mL		900 mL	
KODAK Stabilizer Additive	0.14 mL		0.17 mL	
Water to make	1 L		1 L	

* If biological growth becomes a problem, Proxel GXL may be added at 0.07 mL/L; or Spectrus NX1106 at 0.7 mL/L. Proxel GXL is recommended over Spectrus NX1106 as the NX1106 sometimes causes fog in the developer solution.

Storage of Solutions

Do not use replenishers that have been stored at normal room temperatures 21 to 24°C (70 to 75°F), longer than the times given in Table 9-9. Storage temperatures higher than 24°C (75°F) will decrease the storage life of the solutions. Storage temperatures below 16°C (60°F) can cause some solution constituents to precipitate.

Do not attempt to bring aged replenisher solutions to the formula level. Decomposition products that are formed as the solution stands cannot be eliminated from the solution. These compounds build up to a concentration that can cause adverse photographic effects.

Table 9-9 STORAGE LIFE OF REPLENISHER SOLUTIONS AT 21 TO 24°C (70 TO 75°F)

Replenisher	Floating Cover	Open Tank
Color Developer SD-50Ra, SD-51R	2 weeks	1 week
Stop SB-14	Indefinite*	8 weeks
Others	8 weeks **Closed, Full Glass Container**	8 weeks **Open or Partially Full Container**

* If solution is kept clean.

Discard the remaining few litres of replenisher before fresh replenisher is pumped into the holding tank. Replenisher remaining in the holding tank, even if kept under a close-fitting floating cover, usually has deteriorated to such an extent that it is unsatisfactory for further use.

For best process control, equip the holding tank for the color developer replenisher with a tight-fitting floating cover. The cover will minimize air oxidation of the solution, and absorption of carbon dioxide from the air, which would change the pH. Clearance between the cover and the tank wall should not be greater than $1/4$ inch (6.4 mm). Polyethylene sheeting of $1/2$ inch (12.7 mm) thickness makes adequate covers in sizes up to 3 feet (1 meter) in diameter. A dust cover, alone, permits air to contact more of the solution surface and allows air oxidation to take place. Dust covers should be used for non-developer solutions to minimize dirt in the replenisher tanks.

OPTICAL SOUND PROCESSING

Overview

The sound track is printed onto KODAK VISION Color Print Film / 2383, KODAK VISION Premier Color Print Film / 2393 and KODAK VISION Color Teleprint Film / 2395 / 3395 from a negative sound original. Only the cyan emulsion layer should be exposed. This can be accomplished by using a KODAK WRATTEN Gelatin Filter 29 in the light beam. (Some "ND" filtration may be necessary for optimization.)

In Process ECP-2E, the developer produces a positive silver and dye image of the sound track. As with the image areas, the bleach converts the silver image back to silver halide. The silver halide is removed from the film by the fix. The dye track will be a cyan only image after processing. No special sound track equiment is necessary. If a first fixer is still periodically in use on a processor, it may be skipped by threading the film directly from the stop wash into the bleach or bleach accelerator if no sound track development is required.

An overview of dye sound tracks can be found in *Dye Sound Tracks: A Laboratory Guide*, available from our Entertainment Imaging offices or the Eastman Kodak Company website at *http://www.kodak.com/go/motion*.

Sound Track Operating Specifications

SMPTE Standards 40-2002 and 41-1999 define the location and dimensions of the sound tracks for 35 mm and 16 mm films respectively.

Sound Track Control

The major control parameters in the production of optical sound tracks are the position of the track on the film, the width of the track, and the unmodulated density of the track. The sound track densities are dependent on processing conditions and on the amount of exposure of the sound track during printing. Unlike redeveloped silver or high magenta sound tracks, the optimum density of cyan dye tracks should be measured in Status A density.

The optimal variable-area sound track density on KODAK VISION Color Print Film / 2383 and KODAK VISION Premier Color Print Film / 2393 is between 2.0 and 2.2 (read as Status A density) The blue and green Status A densities should be between 0.2 and 0.4 The filter pack should be adjusted to give the proper green and blue responses. Once a filter pack is found that produces blue and green densities in this range, the red density should be used as the primary quality control parameter. Choose a print density that will provide a good compromise between signal-to-noise ratio and frequency response.

The densities of the sound track negatives required to produce minimum cross-modulation distortion at optimal print densities are determined using recognized cross-modulation test procedures.

Processing KODAK Color Print Films, Module 9
Process ECP-2E Specifications

MORE INFORMATION

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—

http://www.kodak.com/go/motion

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