

**Processing
KODAK
Color Print Films,
Module 9**

**Process ECP-2D
Specifications**

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9 PROCESS ECP-2D 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-2D.

Module 10	Effects of Mechanical and Chemical Variations in Process ECP-2D
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.

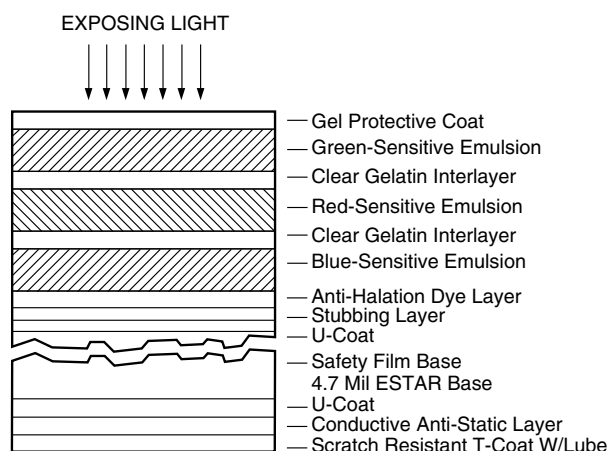
Film 2395 / 3395 is coated on a new ESTAR Base featuring proprietary Kodak technology that replaces rem-jet with process-surviving, anti-static layer, and scratch-resistant backing layer. This film has an efficient antihalation layer under the emulsion layers, using patented solid particle dyes that 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-2D 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. First Fixer	Converts the unexposed and undeveloped silver halide to soluble complex silver thiosulfate compounds that are removed in this fixer and subsequent wash.
5. Wash	Removes residual silver thiosulfate complex compounds that were not removed from the film in the first fixer.
6. Accelerator	Prepares the metallic silver present for the action of the persulfate bleach.
7. 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.
8. Wash	Removes residual bleach from the film, preventing contamination of the following solution.
9. Sound Dry	Dries surface of the film for controlled application of sound track developer.
10. Sound Track Developer	Develops silver halide (in the sound track area only) to a metallic silver image.
11. Sound Track Spray Rinse	Removes any sound track developer that might contaminate the second fixer, or cause development outside the sound track area.
12. Second 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.
13. Wash	Removes unused fixer and the residual soluble silver thiosulfate complex salts formed during fixing.
14. Final Rinse	Prepares the film for drying.
15. Dryer	Dries film for subsequent handling.
16. Lubrication	Promotes longer print projection life. It may be an in- or off-line operation. See Module 2, <i>Equipment and Procedures</i> .

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.

Sensitometric Effects of Bleach

The sensitometric results obtained with the persulfate bleach are slightly different from those obtained with the ferricyanide bleach because of the persulfate bleach's effectiveness in removing residual dyes from the film. In general, higher densities are to be expected with ferricyanide and UL bleaches throughout the tonal scale. Approximate differences with these bleaches are + 0.01 Red, + 0.01 Green, and + 0.02 Blue higher density.

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 improves significantly during long-term storage, 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*.

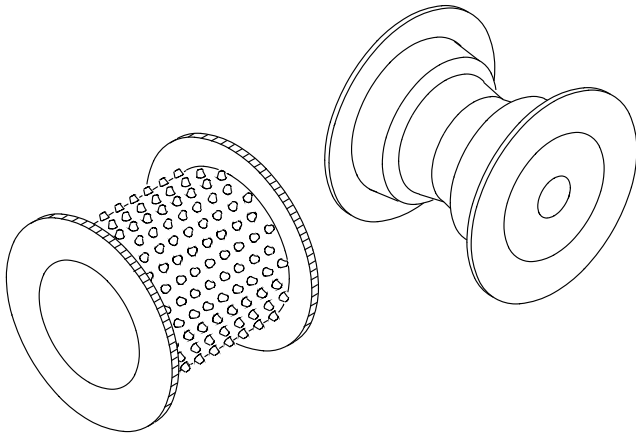
PROCESSING MACHINE DESIGN AND CONSTRUCTION

Machine Design

The films intended for Process ECP-2D 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*.

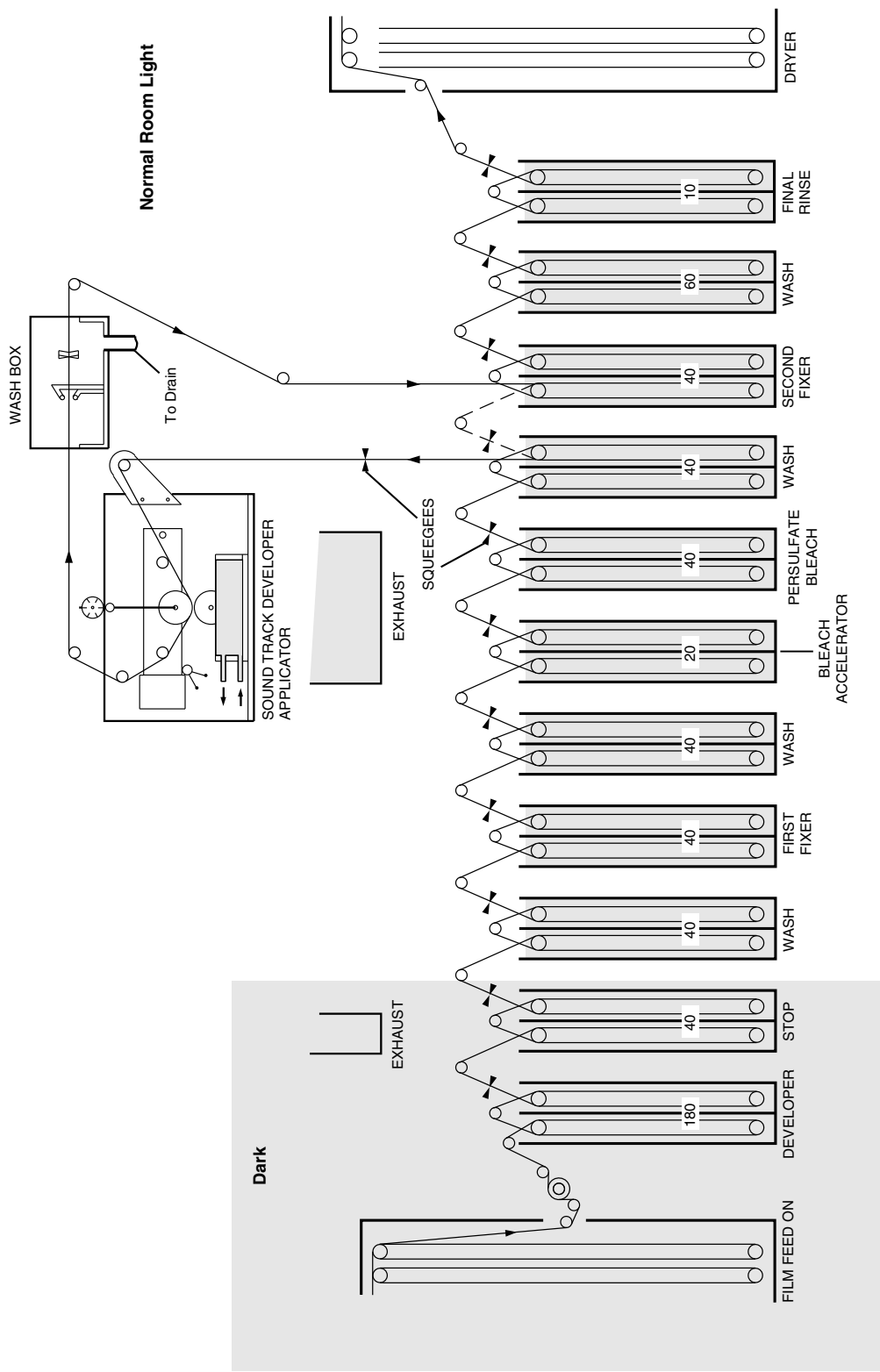
The processor should be a conventional deep-tank machine. Submerged rollers and rack-drive assemblies are recommended for all solutions to minimize the splattering of solutions and aerial oxidation of the developer and fixer. Figure 9-3 is a schematic of a typical processing machine for Process ECP-2D using the recommended persulfate bleach. Figure 9-4 is a schematic of a typical processing machine for Process ECP-2D 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.

The design of equipment for sound track processing is covered in *Optical Sound Processing*.

Eastman Kodak Company does not market processing machines or auxiliary equipment suitable for Process ECP-2D. 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.

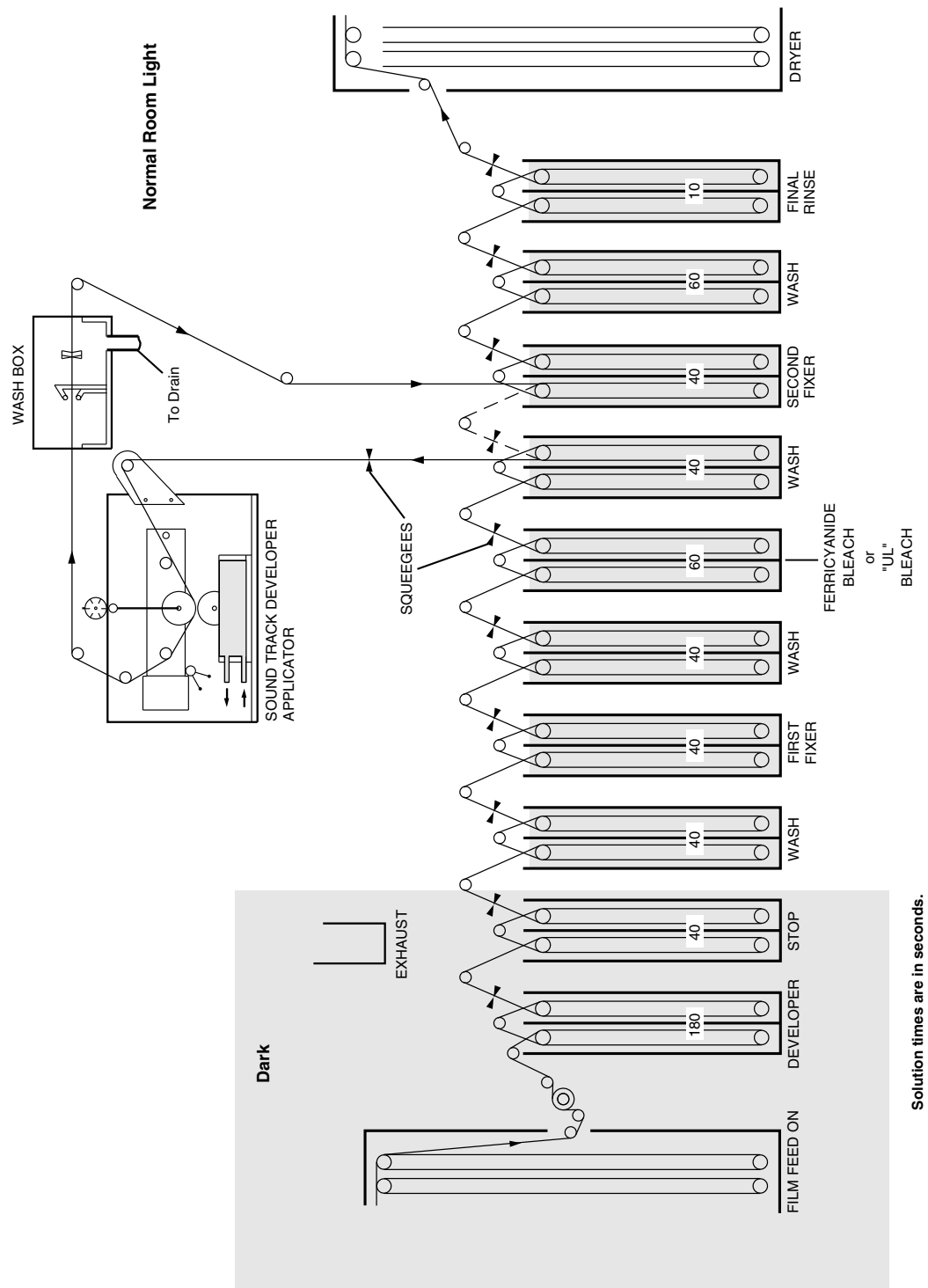
Figure 9-3 Machine Schematic for Process ECP-2D with Persulfate Bleach Sequence



Solution times are in seconds.

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



Solution times are in seconds.

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 make 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-2D

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 pot exceeds 10 psig (69 kPa).

Polypropylene, fiber glass, or bleached cotton are acceptable filter media for all Process ECP-2D solutions. *Viscose rayon is not recommended* for use with the prebath or 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-2D 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*.

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

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 Tetrastarate solution (RP 48-1984). See Module 2, *Equipment and Procedures*, for formulas and details.

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 level 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.

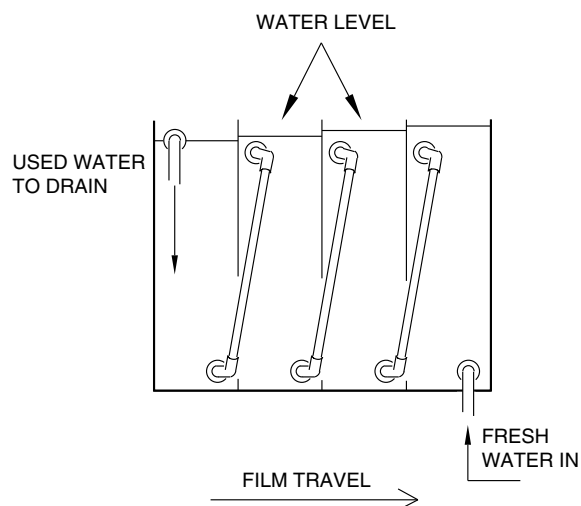
Exhausts need not fit tightly over tanks, and slots should be placed to draw air away from the operator. The exhaust system should provide an air flow of 175 ft³/min (5 m³/min) for every square foot (0.09 m²) of solution surface, and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank.

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



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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.

OPERATING SPECIFICATIONS

Mechanical Specifications

The recommended mechanical specifications for Process ECP-2D 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-2D 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-2D 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
First Fixer	F-35b	F-35bR	27 ± 1	80 ± 2	:40	200 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
Dry film surface before sound track developer application.							
Sound Track Developer	SD-43b	—	Ambient		:10 to :20	—	None
Spray Rinse	—	—	27 ± 3	80 ± 5	:01 to :02	***	None
Second 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 and first fixer 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.

‡‡ 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. Cascading the first fixer overflow into the second fixer helps conserve chemicals. Further savings from reconstituting desilvered fixer overflow for use as replenisher are possible.

§§ 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.

*** The spray pressure and flow rate depend on machine speed and equipment used.

††† 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-2D 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
First Fixer	F-35d	F-35bR	27 ± 1	80 ± 2	:40	200 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
Dry film surface before sound track developer application.							
Sound Track Developer	SD-43b	—	Ambient		:10 to :20	—	None
Spray Rinse	—	—	27 ± 3	80 ± 5	:01 to :02	¶¶	None
Second 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%	5000ft³/min	3 to 5 min.
	Nonimpingement		43° to 49°C (110° to 120°F)		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 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 ft³/min (5 m³/min) for every square foot (0.09 m²) of solution surface and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank.

†† 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 are recommended for stop and first fixer washes. 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.

‡‡ 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. Cascading the first fixer overflow into the second fixer helps conserve chemicals. Further savings from reconstituting desilvered fixer overflow for use as replenisher are possible.

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

¶¶ The spray pressure and flow rate depend on machine speed and equipment used.

*** 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-2D 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	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 mL††	None
First Fixer	F-35d	F-35bR	27 ± 1	80 ± 2	:40	200 mL‡‡	R & F @ 40 to 60 L/min
Wash	—	—	27 ± 3	80 ± 5	:40	1.2 L††	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
Sound Track Developer	SD-43b	—	Ambient		:10 to :20	—	None
Spray Rinse	—	—	27 ± 3	80 ± 5	:01 to :02	¶¶	None
Second 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%	5000ft³/min	3 to 5 min.
	Nonimpingement		43° to 49°C (110° to 120°F)		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 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 ft³/min (5 m³/min) for every square foot (0.09 m²) of solution surface and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank. The exhaust system should produce an air flow of 175 ft³/min (5 m³/min) for every square foot (0.09 m²) of solution surface, and provide 50 to 75 ft/min (15 to 23 m/min) control velocity over the surface of the tank.

†† 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 are recommended for the stop and first fixer washes. 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.

‡‡ 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. Cascading the first fixer overflow into the second fixer helps conserve chemicals. Further savings from reconstituting desilvered fixer overflow for use as replenisher are possible.

§§ 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.

¶¶ The spray pressure and flow rate depend on machine speed and equipment used.

*** 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 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.

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: $10 \text{ mL} \times 1.35 \text{ grams ammonium acetate per gram acetic} = 13.5 \text{ grams ammonium acetate}$. The amount of ammonium hydroxide to subtract is: $2.2 \text{ mL ammonium hydroxide per mL of acetic or } 2.2 \times 10 = 22 \text{ mL}$. The formula becomes zero acetic acid, 13.5 grams of ammonium acetate and 8 mL of ammonium hydroxide.

“Dissolvine MP” is a PDTA Ferric Potassium Solution, [1,3 PDTA-Fe] K, that contains approximately 48 g of total Fe / L of solution. It may be used in any Potassium UL Bleach formulation by substituting “Dissolvine MP” for the entire amounts of KODAK Chelating Agent No. 1 (PDTA) and Ferric Nitrate (Nonahydrate) in the formulation. A potassium UL bleach can be made by using 20.8 mL of “Dissolvine MP” for each gram of total Fe in the formula and removing any KODAK Chelating Agent No. 1 (PDTA) and Ferric Nitrate (Nonahydrate) from the formulation. For example, if the total amount of Fe in a Potassium UL Bleach replenisher is 10 g/L, 1 L of that bleach replenisher could be made by substituting 208 mL of “Dissolvine MP” for all the KODAK Chelating Agent No. 1 (PDTA) and Ferric Nitrate (Nonahydrate) in the formulation. “Dissolvine MP” is a colored solution and its use will result in darker colored bleach replenisher and tank solutions.

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-2D developer to provide uniform film processing. The turbulators are used submerged in the solution and are located in such a way that the recirculated solution impinges uniformly over the full width of the film strand.

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-2D*, *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 stop wash will result in a high level of Color Developing Agent CD-2 in the first fixer.

First Fixer Wash

If the bleach pH is decreasing too rapidly, at normal replenishment rate and replenisher pH, the first fixer wash rate may be insufficient.

Bleach Wash

If using the alternate cycle with ferricyanide bleach, an inefficient bleach will cause excessive buildup of bleach-fixer reaction products in the second 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-2D-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-2D 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 to 100	3:00	300 mL‡	None
Final Rinse	FR-1	21 to 38	70 to 100	: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.

Reprocessing

The removal of silver deposited in the picture area by a splash of sound track developer during application can be accomplished by reprocessing. The film is reprocessed in the original process, using a modified sound track developer, and bleach accelerator (or bleach). Using the modified sound track developer SD-43b (addition of 4 g/L potassium iodide) during normal processing makes removal of silver splash stain much more effective during reprocessing.

Persulfate Bleach

During reprocessing, the Accelerator Agent PBA-1 concentration is increased to replenisher level, and the film time in the accelerator is doubled.

Steps:

1. Raise the PBA-1 concentration to replenisher level.
 - Weigh out the amount of PBA-1 required to bring the tank level up to replenisher level. The difference between PBA-1 tank and replenisher level is 1.6 g/L.
 - For each gram of PBA-1 to be added, weigh and add 0.4 grams of sodium bisulfite to a 10 litre mixing pail or suitable container. Dissolve the sodium bisulfite in the minimum of accelerator solution taken from the machine tank.
 - Dissolve the PBA-1 in the solution in the pail.
 - Add the "PBA-1/Bisulfite solution" to the machine accelerator tank and recirculate for 10 to 15 minutes.
2. Prepare the machine for sound track application using SD-43b containing 4 g/L potassium iodide.
3. Increase the film time in the accelerator from 20 to 40 seconds by extending the racks or slowing the machine.
4. Reprocess the affected film. Replenish the accelerator at normal replenishment rates.
5. To resume normal processing, revert to normal processing times. The extra PBA-1 in the machine tank will not adversely affect the process, and will dilute to normal levels with normal replenishment.

Ferricyanide Bleach

During reprocessing, increase the bleach tank ferricyanide concentration to 40 g/L.

Steps:

1. Raise the ferricyanide concentration to 40 g/L.
 - Weigh out the amount of anhydrous potassium ferricyanide required to bring the tank level up to 40 g/L. The normal potassium ferricyanide tank level is 30 g/L.
 - Add the potassium ferricyanide to a 10 litre mixing pail or suitable container. Dissolve the potassium ferricyanide in the minimum of bleach solution taken from the machine tank.
 - Add the potassium ferricyanide solution to the machine bleach tank and recirculate for 10 to 15 minutes.
2. Prepare the machine for sound track application using SD-43b containing 4 g/L potassium iodide.
3. Reprocess the affected film. Replenish the bleach at normal replenishment rates with regular replenisher.
4. To resume normal processing, no special action is required. The extra-strength bleach in the machine tank will not adversely affect the process, and will dilute to normal levels with normal replenishment.

UL Bleaches

Steps:

1. Prepare the machine for sound track application using SD-43b containing 4 g/L potassium iodide.
2. Reprocess the affected film. Replenish the bleach at normal replenishment rates with regular replenisher.

PROCESSING CHEMICALS AND FORMULAS

Packaged Chemicals

Kodak packaged chemical kits are available for the solutions used in Process ECP-2D. 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 ₃ COOH	Fisher Scientific	800-766-7000
		Brown Chemical Company	201-337-0900
Ammonium Bromide	NH ₄ Br	Ameribrome, Inc.	212-286-4000
		Pechiney World Trade USA	800-736-7893
Ammonium Hydroxide (28% Solution)	NH ₄ OH	Fisher Scientific	800-766-7000
		Mallinckodt, Inc.	800-554-5343
		Van Waters and Rogers	425-889-3400
Ammonium Thiosulfate	(NH ₄) ₂ S ₂ O 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 Bleaching Agent BL-1		Eastman Kodak Company	800-621-3456
Borax, Decahydrate*	Na ₂ B ₄ O ₇ •10H ₂ O	Ashland Chemical Company	614-790-3333
		US Borax and Chemical Corporation	800-872-6729
Borax, Pentahydrate*	Na ₂ B ₄ O ₇ •5H ₂ O	Ashland Chemical Company	614-790-3333
		US Borax and Chemical Corporation	800-872-6729
KODAK Chelating Agent, No. 1	—	Eastman Kodak Company	800-621-3456
KODAK Color Developing Agent, CD-2	—	Eastman Kodak Company	800-621-3456
Dissolvine PDZ	PDTA, C ₁₁ H ₁₈ N ₂ O ₈	Akzo Nobel Functional Chemicals	800-906-7979
Dissolvine MP	PDTA Ferric Potassium Solution, [1,3 PDTA-Fe] K	Akzo Nobel Functional Chemicals	800-906-7979
Ethylene-diamine*	NH ₂ CH ₂ CH ₂ NH 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

Chemical or Trade Name	Formula or Chemical Name	Some Suppliers	Supplier Phone Number
Ferric Nitrate Nonahydrate*	$\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$	Mallinckodt, Inc.	800-554-5343
		Shepherd Chemical Company	513-731-1110
		General Chemical Company	973-515-0900
Formalin, (Formaldehyde, 37.5% Solution)	CH_2O	Fisher Scientific	800-766-7000
		Ashland Chemical Company	614-790-3333
Gelatin	—	American Gelatin Company	781-933-2800
Hexylene Glycol	2-Methyl-2, 4-pentanediol	Union Carbide Corporation	800-568-4000
		Ashland Chemical Company	614-790-3333
		Shell Chemical Company	800-872-7435
Hydroquinone*	Paradihydroxybenzene	Fisher Scientific	800-766-7000
		Aldrich Chemical Company, Inc.	414-273-3850
		Aceto Corporation	516-627-6000
Natrosol 250HR	Hydroxyethylcellulose	Hercules, Inc.	800-334-8426
		Union Carbide Corporation	800-568-4000
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*	$\text{K}_3\text{Fe}(\text{CN})_6$	Ashland Chemical Company	516-627-6000
Potassium Iodide*	KI	Anachemia Chemicals, Inc.	800-323-1414
		Mallinckrodt, Inc.	800-554-5343
Potassium Persulfate*	$\text{K}_2\text{S}_2\text{O}_8$	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*	NaCl	Ashland Chemical Company	614-790-3333
		Mallinckodt, Inc.	800-554-5343
		American International Chemical Company	508-655-5805
Sodium Phosphate, Monobasic, Anhydrous*	NaH_2PO_4	Pechiney World Trade USA	800-736-7893
		Degussa-Huls Corporation	201-641-6100
Sodium Ferrocyanide, Decahydrate*	$\text{Na}_4\text{Fe}(\text{CN})_6 \cdot 10\text{H}_2\text{O}$	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	NaOCl	Ashland Chemical Company	614-790-3333
		Brown Chemical Company	201-337-0900
		Delta Chemical Company	410-354-0100

Chemical or Trade Name	Formula or Chemical Name	Some Suppliers	Supplier Phone Number
Sodium Metabisulfite Anhydrous*	$\text{Na}_2\text{S}_2\text{O}_5$	Fisher Scientific	800-766-7000
		BASF Corporation	800-426-8702
		American International Chemical Company	508-655-5805
Sodium Persulfate*	$\text{Na}_2\text{S}_2\text{O}_8$	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

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-2D*, 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.

SOUND-TRACK DEVELOPER: The starting water temperature must be in the recommended range. Starting in this range results in a heated solution of 32 to 38°C (90 to 100°F) after the sodium hydroxide has

dissolved. This heated solution helps the Natrosol 250 HR to dissolve. A starting water temperature higher than recommended can be hazardous, as the temperature can rise with the addition of the sodium hydroxide to a point where water vapor containing sodium hydroxide is given off.

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 flowrate 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 flowrate 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.

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 g/L	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
CD-2 Contamination§		less than 0.05 g/L		

* These values are for the first fixer and, depending on machine design, might be slightly different for second fixer.

† Test method (using 3 mL sample) measures sulfite and bisulfite together as total sulfite (Na₂SO₃).

‡ 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 sulfuration of the fixer.

§ At higher CD-2 levels than designated, stain can occur because all the developing agent may not be removed from the film before the bleaching step.

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*
CD-2 Contamination§		less than 0.05 g/L		

* These values are for the first fixer and, depending on machine design, might be slightly different for second fixer.

† Test method (using 3 mL sample) measures sulfite and bisulfite together as total sulfite (Na₂SO₃).

‡ 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 sulfuration 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.

§ At higher CD-2 levels than designated, stain can occur because all the developing agent may not be removed from the film before the bleaching step.

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
CD-2 Contamination§		less than 0.05 g/L		

* These values are for the first fixer and, depending on machine design, might be slightly different for second fixer.

† Test method (using 3 mL sample) measures sulfite and bisulfite together as total sulfite (Na₂SO₃).

‡ 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.

§ At higher CD-2 levels than designated, stain can occur because all the developing agent may not be removed from the film before the bleaching step.

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 mL/L‡
Persulfate Bleach Accelerator PBA-1	3.3 g	3.3 ± 0.3 g/L	4.9 g	4.9 ± 0.3 g/L
or		or	or	or
KODAK liquid PBA-1§	4.0 mL	4.0 ± 0.4 mL/L	5.9 mL	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 (Na₂S₂O₅). 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.

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 ₄ Br) 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 mL of 35% solution/L in Tank, and 80.2 mL of 35% solution/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.

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.

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 or 2.5 N sulfuric acid.

Sound Track Developer*

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Sound Track Developer	(SD-43b)			
Water 10-16°C (50-60°F)*	800 mL			
Sound Coating Aid (Natrosol 250HR)†	2.0 g			
Sodium Hydroxide	80 g			
Hexylene Glycol	2.0 mL			
Sodium Sulfite (Anhydrous)	50 g‡			
KODAK Hydroquinone	60 g			
Ethylenediamine (98% by Weight)	13 mL			
Water to make	1 L§			
WARNING! Causes eye burns, skin irritation, and allergic skin reaction. Avoid contact with eyes, skin and clothing. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. In case of eye contact, get medical attention.				

* Start with mix water in the recommended temperature range to achieve a heated solution 32-38°C (90-100°F) after the sodium hydroxide has been dissolved. A starting water temperature higher than recommended may be hazardous, as the temperature can rise after addition of sodium hydroxide to a point where water vapor containing sodium hydroxide is given off.

† Natrosol is a trademark for hydroxyethylcellulose. Natrosol 250HR is manufactured by Hercules, Inc., Coating and Specialty Products Department, Hercules Plaza, Wilmington DE 19894. Sift slowly into solution with good continuous agitation, taking care not to aerate the solution. A homogenous mixture should be obtained in 45 to 60 minutes.

‡ Before adding hydroquinone, cool the solution to room temperature.

§ If occasional removal of silver from the picture area is needed because of improperly coated sound track developer, add 4 g/L potassium iodide to this formula prior to reprocessing.

Alternate Sound Track Developer*

Constituent	Fresh Tank	Fresh and Seasoned Tank Analytical Specifications	Fresh Replenisher	Replenisher Analytical Specifications
Ascorbic Acid Sound Track Developer				
Water 10-16°C (50-60°F)*	800 mL			
Sound Coating Aid (Natrosol 250HR)†	3.8 g			
Sodium Hydroxide	80.0 g			
Hexylene Glycol	2.0 mL			
Sodium Sulfite (Anhydrous)	16 g			
Ascorbic Acid‡	33 g			
Ethylenediamine (98% by Weight)	13.0 mL			
ELON	1.2 g			
Water to make	1 L§			
WARNING! Causes eye burns, skin irritation, and allergic skin reaction. Avoid contact with eyes, skin and clothing. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. In case of eye contact, get medical attention.				

* Start with mix water in the recommended temperature range to achieve a heated solution 32-38°C (90-100°F) after the sodium hydroxide has been dissolved. A starting water temperature higher than recommended may be hazardous, as the temperature can rise after addition of sodium hydroxide to a point where water vapor containing sodium hydroxide is given off.

† Natrosol is a trademark for hydroxyethylcellulose. Natrosol 250HR is manufactured by Hercules, Inc., Coating and Specialty Products Department, Hercules Plaza, Wilmington DE 19894. Sift slowly into solution with good continuous agitation, taking care not to aerate the solution. A homogenous mixture should be obtained in 45 to 60 minutes.

‡ Before adding ascorbic acid, cool the solution to room temperature.

§ If occasional removal of silver from the picture area is needed because of improperly coated sound track developer, add 4 g/L potassium iodide to this formula prior to reprocessing.

* This developer was formulated for use with a typical wheel applicator at a processor speed of ~100 feet per minute. Modifications to the hexylene glycol level and the Natrosol level are necessary when higher processing speeds, or other types of applicators are used.

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
Sound Track Developer, SD-43b	1 week	1 day

* 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 $\frac{1}{4}$ 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 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 top two emulsion layers should be exposed. This can be accomplished by using a filter pack comprised of KODAK WRATTEN Gelatin Filter No. 2B* and No. 12 in the light beam.

In Process ECP-2D, the developer produces a positive silver and dye image of the sound track. The first fixer removes undeveloped silver halide from the sound track area. Next the bleach converts the silver sound track image back into silver halide. A sound developer is inserted between the bleach wash, which should be a 40-second deep-tank wash, and the second fixer.

This fogging developer reduces the silver halide in the sound track to a positive silver image once again. The silver and dye sound track image is not appreciably affected by the remaining processing steps.

* Practical test data indicate the No. 2B filter may be omitted without significant loss of sound quality. Retention of the 2B filter is an operational convenience to conform with printer setups for other products which require the 2B filter.

Sound Track Equipment

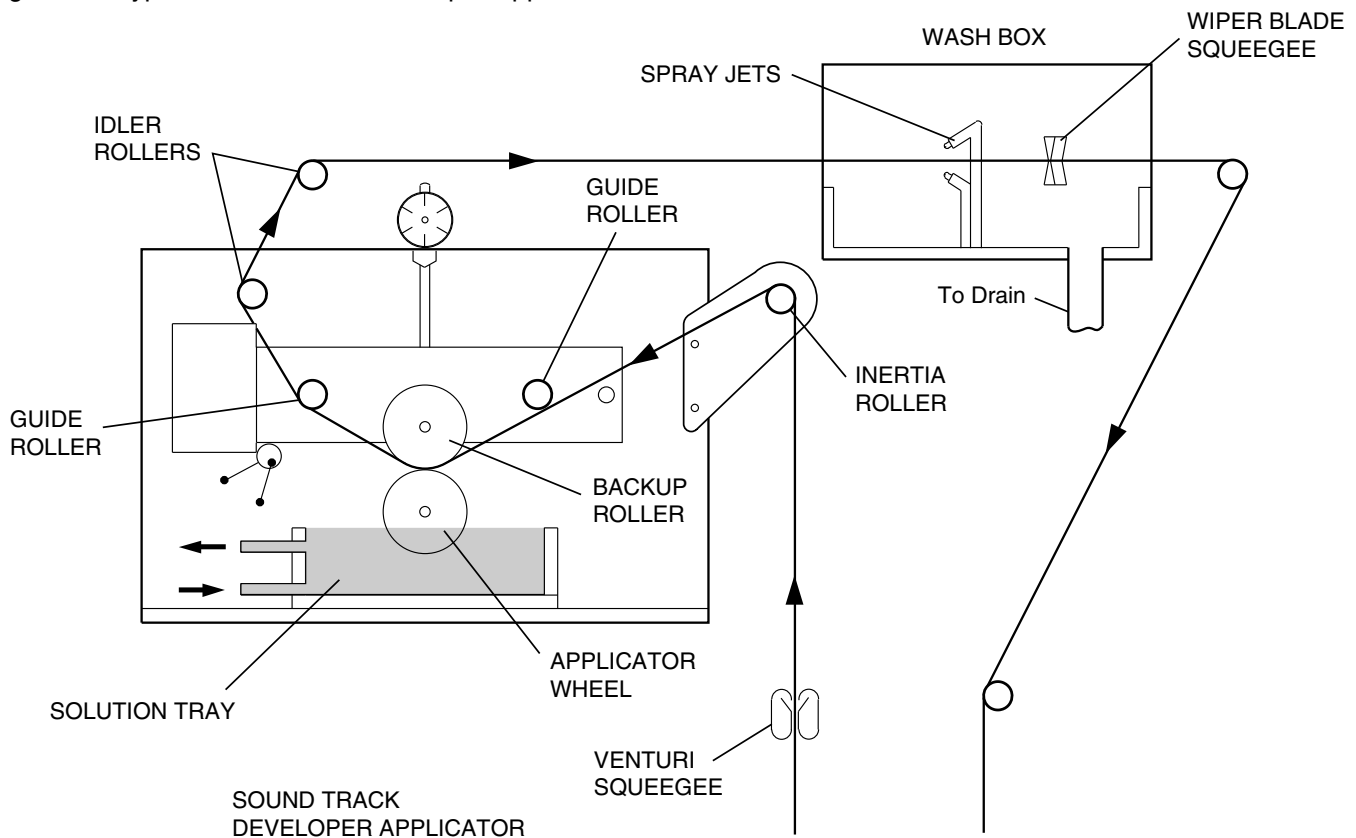
Figures 9-3 and 9-4 include a schematic of a sound track developer applicator. A close-up of this equipment is illustrated in Figure 9-6.

The equipment recommended for the process sequence between the bleach wash and the second fixer, consists of:

Squeegees

To prevent bleeding of the sound track developer into the picture area, the surface of the color print films must be dried sufficiently before sound track developer application. This can be accomplished with a wiper-blade squeegee followed by an efficient venturi air squeegee using heated air. The air entering the squeegee must be at 38°C (100°F) or greater. It is very important to keep the air slits clean at all times. Dirty or plugged slits will cause incomplete surface drying and improper sound track treatment. As an added precaution, a filter can be placed in the air line just before the squeegee, even though there may be another filter in the air line.

Figure 9-6 Typical Sound Track Developer Applicator



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Inertia Roller Assembly

The purpose of this assembly is to maintain a constant film speed through the sound track applicator. Uniform speed is necessary to prevent uneven sound developer application. Alternatively, this assembly can be located *after* the applicator.

Guide Rollers

Guide rollers before and after the applicator are necessary to provide correct alignment of the film with the applicator wheel.

Sound Track Developer Applicator

Figure 9-7 shows a typical single-track sound developer applicator. For multitrack films, multiple applicator wheels are needed.

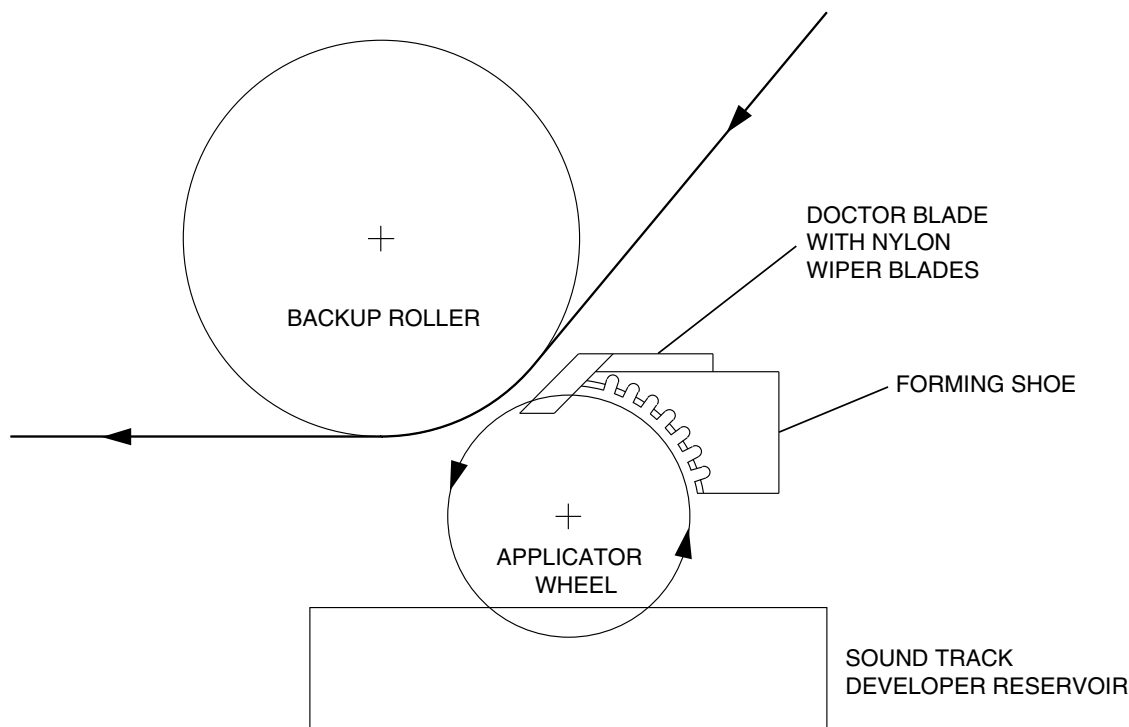
As shown in Figure 9-6, the film enters the applicator under the first guide roller. It then passes between the applicator wheel and the backup roller and out under the second guide roller. As the film passes across the backup roller, it drives the applicator wheel through a gear train. The applicator wheel dips into the sound track developer reservoir and carries this viscous solution on its periphery.

When the applicator wheel is raised close enough to the film, or the backup roller is lowered so the film is close enough to the applicator wheel, the film picks up a bead of developer. The wheel must be positioned so that it coats the sound track area of the film. The width of the bead can be controlled by varying the size of the gap between the applicator wheel and the backup roller. Table 9-10 gives setup applications for a machine applying in the 160 fpm speed range.

Table 9-10 Sound Track Developer Coating Setup Specifications (Film Speed 160 fpm)

Parameter	16 mm	35 mm
Width of applied bead	0.097 in. (2.46 mm)	0.116 in. (2.94 mm)
Width of applicator wheel	0.090 in. (2.30 mm)	0.100 in. (2.54 mm)
Distance from center-line of bead to near edge of film	0.058 ± 0.002 in. (1.47 ± 0.05 mm)	0.250 ± 0.002 in. (6.35 ± 0.05 mm)
Distance between applicator wheel and backup roller	0.006 in. (0.15 mm)	0.007 in. (0.18 mm)
Applicator wheel rim velocity	Same as film velocity (1:1 gearing with backup roller)	
Direction of applicator wheel rotation	Same as that of film	
Developer temperature	Room temperature	
Development time (reaction path length)	10 to 20 sec. (30 to 50 ft)	

Figure 9-7 Sound Track Developer Applicator

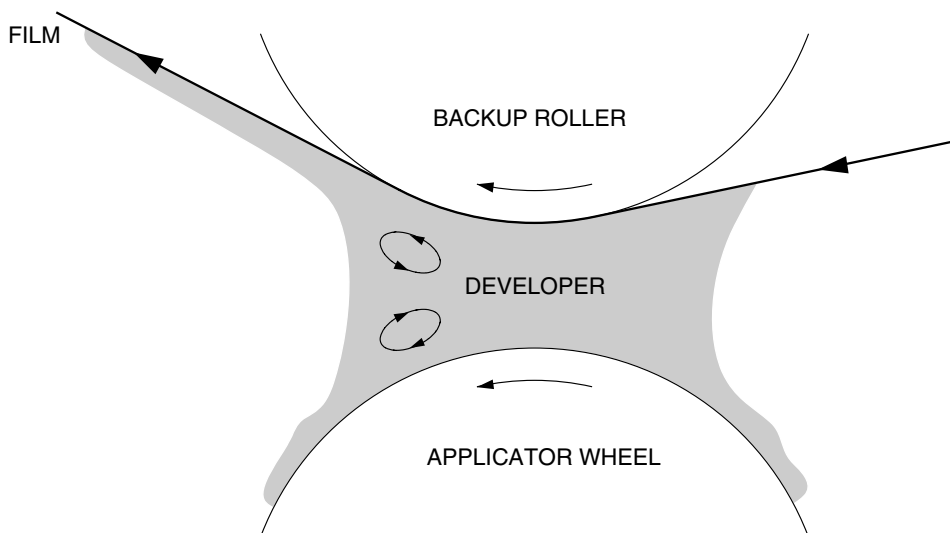


In moderate speed applications, (500 to 600 fpm range), the fluid dynamics begin to change, tending toward greater turbulence. Design optimization can help restore the required laminar flow condition.

At normal speeds, Figure 9-8, with the wheel and roller rotating in the same direction as the film travel, a controllable application can result. At high speeds (600 + fpm), the meniscus starts to become unstable as developer builds up in the turbulent area at the left of Figure 9-8.

Other changes required at higher speed operation include increased pre-application film drying, and increased developer viscosity. The developer formulation optimal ratio of thickening agent to surfactant changes, and becomes more critical, as applying speeds increase; therefore, each applying station will require unique optimum setup specifications.

Figure 9-8 Cocurrent Developer Application

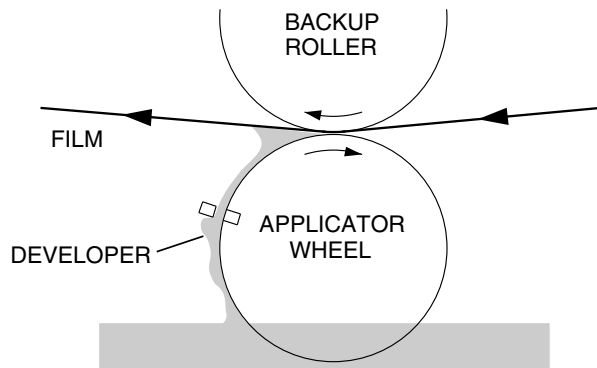


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Cocurrent Developer Application: As application speed increases, liquid starts to flow back into the coating region. This leads to an unstable meniscus because liquid is continuously being brought to this region by the applicator wheel.

Using a counter rotating applicator wheel, Figure 9-9, restored stability to the meniscus allows controlled application again. At speeds approaching 1000 fpm, new mechanics of applying, such as extrusion type applying, seem necessary.

Figure 9-9 Countercurrent Developer Application



Countercurrent Developer Application: In this geometry the applicator wheel moves opposite the flow of fluid on the film, minimizing the unstable meniscus effects.

Idler Roller Assembly

This assembly provides a suitable arrangement of the film path to allow the required 10- to 20-second development time before the wash box.

Wash Box

The excess sound developer bead remaining on the film and the unreacted developer absorbed in the emulsion must be removed to prevent subsequent contamination of the picture area in the second fixer. This can be accomplished with a wash box containing a spray rinse and squeegee as shown in Figure 9-6. Place the spray nozzles so that streams of water are directed across both sides of the film toward the sound track edge. Adjust the water pressure to obtain a thorough rinsing. Angle a wiper blade squeegee to direct the rinse water off the sound track edge of the film. Collect the rinse water in a catch basin with a connection to the drain.

Sound Track Operating Specifications

In sound track development, the most critical specifications are the width and location of the applied bead. ANSI Standards PH22.40-1984 and PH22.41-1983 define the location and dimensions of the sound tracks for 35 mm and 16 mm films respectively. It is essential that the sound developer bead cover the area scanned by the sound reproducer in a projector. However, it is equally important to prevent sound developer from getting into either the perforations or the picture area of the film. The applicator wheel width, velocity, spacing from backup roller, etc., affect the width of the applied bead. For a particular sound processing installation, the normal single adjustment at the time of application to obtain the desired bead width is to fine-tune the distance between the applicator wheel and the backup roller. Of course, the film must be properly aligned with the applicator before coating starts.

Adequate developer solution must be maintained in the applicator reservoir, but the solution level is not critical. A gravity-feed device can be used to supply developer to the reservoir.

Precise specifications to provide good uniformity of sound track development must be determined specifically for each processing installation. The specifications in Table 9-10 are intended to be helpful starting points for equipment design and use.

Sound Track Developer Chemicals

The viscosity of this solution is critical to proper sound track developer coating and bead width. Be certain that it is mixed correctly and consistently from batch to batch.

The viscosity of the sound track developer can be monitored by measuring the solution discharge time from a pipet. A 10 mL, Class A, volumetric or transfer pipet* is suggested. Your laboratory will have to establish its standard discharge time, using solutions that can be satisfactorily applied. The pipet must be clean, and the solution must always be tested at the same temperature. The same pipet should be used for all measurements, since discharge time can vary among pipets. See Module 3, *Analytical Procedures*, for a viscosity check method (ECP-2-99) and Method ULM-0005/1 for techniques on using a pipet.

* One suitable pipet is the Kimax-51, Class A, unserialized, or equivalent, available from most scientific supply houses.

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. A densitometer capable of density measurements at 900 nm (infrared) is needed for sound track density control.

The optimal variable-area sound track density on KODAK VISION Color Print Film / 2383 and KODAK VISION Premier Color Print Film / 2393 is between 1.1 and 1.8, and for KODAK VISION Color Teleprint Film / 2395 / 3395 between 1.1 and 1.5 (read at 800 nm). 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.

Procedures for sound track start-up and shut-down, as well as maintenance information, are given in Module 2, *Equipment and Procedures*, under *Sound Track Processing Equipment*.

Sound Track Application Detector

Typical problems that occur during the application of a silver sound track are splashes of developer into the picture area and skips in the track area. A sound track application detector capable of detecting and signaling these defects on 16 mm film is described in a paper by T. S. Silliman and R.E. Uhlig, "Sound Track Application Detector," *Journal of the SMPTE*, 93:948, October 1984. The detector uses an infrared light-emitting diode as a light source which illuminates the film at the boundary between the sound-track and picture areas. One segment of the dual-element photocell collects the light passing through the picture area to detect high density caused by too wide application and/or spattering of developer. The other segment collects a fall in density caused by a skip in developer application. Alarms are sounded if the detector finds these problems. The unit can be mounted after the light lock in the film drying cabinet.

J.O.Baker and D. H. Robinson, "Modulated High-Frequency Recording as a means of Determining Conditions for Optimal Processing." *Journal of the SMPE*, 30:3-17, January 1938.

Troubleshooting Guide

Use the following outline as a troubleshooting guide for sound track control:

Stripe Too Wide

Contamination of the picture area must be avoided.

1. Check the application/film gap. It may be too narrow.
2. Check whether the squeegees before the developer applicator are adequately drying the film.
3. Check the developer viscosity. It may be too low.
4. Remix the developer. The hexylene glycol level may be too high.

Stripe Too Narrow

This condition can cause sound distortion, improper volume, and noise.

1. Check the applicator/film gap. It may be too wide.
2. Check the applicator wheel for grease and dirt. Remove grease with a solvent.
3. Check the developer viscosity. It may be too high.
4. Remix the developer. The hexylene glycol level may be too low.

Stripe Varies in Width Systematically

This condition can cause sound distortion, improper volume, and noise. A certain amount of width variability is normal with density changes. Check:

1. The backup roller and applicator wheel for dirt.
2. The applicator gap.
3. For damage to the backup roller or applicator wheel shafts or bearing (if the problem is severe). If the bearings are replaced, the applicator wheel may need to be reground to obtain concentricity on the new bearings.

Stripe Weaves

This condition can cause sound distortion, improper volume, and noise. Check:

1. The guide rollers for dirt.
2. Alignment of guide rollers.

Stripe Erratic or "Blippy"

This condition can cause sound distortion, improper volume, and noise.

1. Check the applicator gap. The solution bead should be neither squashed nor stretched.
2. Determine if the film is sufficiently dry prior to sound track developer application. Also, check temperature of air in sound track venturi squeegee.
3. Check the applicator for dirt.
4. Examine the film drive through the applicator to see if it is free of vibrations and hesitations. Also, check the performance of the inertia roller bearings.
5. Check for particles in the sound developer.
6. Check for viscosity of the developer.
7. Check whether an adequate level of developer is being maintained in the tray.
8. Remix the sound track developer, since hexylene glycol level may be too low.

Stripe Outside Edges Rough or "Jagged"

1. Check the gap between the applicator and the film. It may be too wide.
2. Check that the film is adequately dried, but not over-dried.
3. Check the applicator wheel to be sure it is not worn or out of alignment.
4. Check that the hole or holes in an extrusion applicator are not partially clogged or too small for the speed of the machine.
5. Check to be sure that the meniscus is stable and that airflow and vibration are not disturbing the application.
6. Check the viscosity of the sound developer.
7. Hexylene glycol level may be too low. Higher than indicated levels (2X) of hexylene glycol may be evaluated to aid in application uniformity.
8. Check that the sound developer time is adequate and not too short.

Dark Streaks, Flutter, or Spots in the Picture Area

1. Examine the negative original for defects or dirt.
2. Inspect the wash box for faulty operation.
3. Check squeegee before sound track developer to be sure it is properly drying the film surface.

Processing KODAK Color Print Films, Module 9

Process ECP-2D 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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