1 CHEMICALS AND CHEMICAL HANDLING

Chemicals

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

This section describes:

- Chemical terms
- Processing solution effects
- Safe handling of photographic chemicals
- Chemicals for your SM Minilab
- Chemical mixing
- Solution storage
- Compensating for evaporation
- Processor maintenance
- How to dispose of effluent and chemicals
- Solid waste disposal

Chemical Terms

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

Chemical Concentrates or Concentrates—Chemicals contained in the SM Processing Units, or in bottles of the SM tank mixes, that are used to replenish the tank solutions or to make the tank solutions in the processor.

F1—First of two replenishment units for Process C-41SM.

F2—Second of two replenishment units for Process C-41SM.

P1—First of two replenishment units for Process RA-2SM.

P2—Second of two replenishment units for Process RA-2SM.

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

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

Processing Solution Effects

How Each Processing Solution Affects Your Results

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

Developer—contained in SM Processing Units F1 and P1—The developer chemically reduces the exposed silver halide in the film or paper to form a metallic silver image. At the same time, the color developing agent in the developer oxidizes and combines with the dye couplers at the site of the silver image in each of the dye-forming emulsion layers to form a color image. Once the dye image has formed, there is no need for the silver image. It is removed by bleaching and fixing.

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

Bleach—contained in SM Processing Unit F2—In the film process, the bleach stops developer activity and converts metallic silver into silver halide. The silver halide is dissolved in the fixer. Most paper processes combine the chemical reactions of bleaching and fixing in a single bleach-fix solution

Bleach concentration and the rate at which the solution diffuses into the emulsion affect bleach activity. Time, agitation, and temperature affect the rate of diffusion. Replenishment rate and aeration efficiency affect the chemical concentrations. Bleach aeration adds oxygen needed to convert the reduced bleaching agent to an active form.

If bleaching is inadequate, less than the normal amount of cyan dye is formed because some of the dye remains in the leuco (colorless) condition. This affects the color balance. A bleach tank solution that is too dilute or insufficient bleach aeration can cause leuco-cyan dye to form.

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

Fixer—contained in SM Processing Unit F2—In a film process, the fixer converts silver halide into soluble silver complexes. Most of these silver complexes remain in the fixer solution; you can recover them with electrolytic silver-recovery units and/or chemical-recovery cartridges. Fixing efficiency depends on fixer activity and the diffusion rate into the emulsion. Temperature and replenishment rate affect fixer activity. Time and agitation affect the diffusion rate.

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

The most probable causes of inadequate fixing are fixer that is diluted by excessive solution carryover, an inadequate fixing time, underreplenishment, and fixer sulfurization. Temperature has very little effect on the fixing rate if other fixer conditions are within tolerances. Agitation is necessary primarily for uniform fixing.

Bleach-Fix—contained in SM Processing Unit P2—The paper process uses a bleach-fix instead of a separate bleach and fixer. A bleach-fix has three primary purposes: to stop the action of the developer, to convert metallic silver into silver halide, and to dissolve the silver halide.

Bleach-fix performance depends on the concentration and the diffusion rate of the solution into the emulsion. Time, agitation, and temperature affect the diffusion rate. Incorrect bleach-fix conditions or an abnormal bleach-fix can affect the amount of dye formed.

Inadequate bleach-fixing may not convert all of the metallic silver to silver halide. A sign of retained silver is an increase in the black-patch (BP) densities and a desaturation of the yellow patch on the control strip (giving it a brown appearance). Retained silver degrades image quality by desaturating the colors—especially yellow—and is most apparent in higher-density areas where there is more silver to convert. You can remove retained silver by reprocessing the paper in a good bleach-fix.

Final Rinse/Stabilizer—contained in SM Processing Unit F1, Version 2.1, is final rinse. Contained in SM Processing Unit P1, Version 2.2, is stabilizer. Both solutions are used to remove residual chemicals from the processed film or paper. In the film process, the final rinse step is also used to provide uniform drying for prevention of drying marks.

SM Chemicals

Chemicals for Your SM Minilab

Kodak is committed to providing minilabs with chemicals that are safe, economical, and easy to use—true SiMplicity. The chemicals designed for SM Minilabs are supplied in liquid concentrates for easy handling. We designed these chemicals to be as safe as possible for our environment.

Table 1-1 KODAK SM Chemicals for SM Minilabs

FEATURES	BENEFITS
• Unique, patented packaging	• No operator exposure to chemicals • Less effluent discharged—less environmental impact
• No replenisher mixing	• Saves time • Less operator training • No mixing errors
• High-quality chemicals optimized for all levels of process utilization	• Little to no process change between peak seasons and times of low utilization
• Process RA-2SM cycle—fast access time	• Prints obtained in less time than Process RA-4 • Quicker results from printer tests and paper process control tests • The EKTACOLOR Processing Cartridge P1, Version 2.2, uses a single-part developer and improved cartridge design. This will help ensure accurate replenishment and ensures complete emptying of the cartridge. Also, increased capacityof this unit (20,000 4 x 6-inch prints) means less inventory to store.

SM chemical concentrates are supplied in processing units that fit directly into the minilab; no mixing is required. Each of the four units—F1, F2, P1, and P2—can **only** fit onto the minilabs in the correct location. The units are also color-coded with corresponding colored labels on the minilab, and each unit has a unique symbol that also matches the minilab, to make operations simple for the operator.

Table 1-2 KODAK SM Chemicals for Process C-41SM and Process RA-2SM

Replenishment Chemicals		
SM Processing Unit	**CAT No*.**	**Description**
FLEXICOLOR / F1 V 2.0	874 0110	Each SM Processing Unit provides enough chemicals to process 900 rolls of 135-24 size film, when paired with an F2 SM Processing Unit. Available in sales units of, 2 SM Processing Units per shipping case.
FLEXICOLOR / F2 V 2.1	117 3319	Each F2 SM Processing Unit, Version 2.1, provides enough chemicals to process 260 rolls of 135-24 size film. Available in sales units of 2 SM Processing Units packed per shipping case.
EKTACOLOR / P1	178 2713	Each SM Processing Unit provides enough chemicals to process 10,000 4 x 6-inch (4R) prints, when paired with a P2 SM Processing Unit. Available in sales units of 2 SM Processing Units per shipping case.
NEW EKTACOLOR / P1 V 2.2	807 9782	Each SM Processing Unit provides enough chemicals to process 20,000 4 x 6-inch (4R) prints. Features single-part developer for improved replenishment and help ensure complete emptying of unit. Available in sales units of 2 SM Processing Units per case.
EKTACOLOR / P2 V 2.1	170 1325	Each P2 SM Processing Unit, Version 2.1, provides enough chemicals to process 8,650 4 x 6-inch (4R) prints. Available in sales units of 2 SM Processing Units packed per shipping case.

* Conversion to F2 and P2 Version 2.1 will begin in mid 2002. At that time, we will discontinue the original catalog numbers.

Working Tank Chemicals / Process C-41SM		
KODAK Chemical	**CAT No.**	**Description**
FLEXICOLOR SM Tank Developer	175 6337	Each unit contains six kits to produce 12 litres of tank solution.
FLEXICOLOR SM Tank Bleach	882 4690	Each package contains two units to produce 5.4 litres of tank solution.
FLEXICOLOR SM Tank Fixer	846 2681	Each package contains two units to produce 7.8 litres of tank solution.
FLEXICOLOR SM Tank Final Rinse	192 5254	Each package contains twelve units to produce 18 litres of tank solution.

Working Tank Chemicals / Process RA-2SM		
KODAK Chemical	**CAT No.**	**Description**
EKTACOLOR SM Tank Developer	861 9769	Each package contains four kits to produce 8 litres of tank solution.
EKTACOLOR SM Tank Bleach-Fix	891 5753	Each package contains two units to produce 12.6 litres of tank solution.
EKTACOLOR SM Tank Stabilizer	872 9956	Each package contains twelve units to produce 36 litres of tank solution.

Chemical Handling

Safe Handling of Photographic Chemicals

Handle all chemicals carefully. For more information about potential health hazards and safe handling of specific Kodak chemicals, see the label and the Material Safety Data Sheet (MSDS) for the chemical or call the Kodak health, safety, and environmental information line at (585) 722-5151, 24 hours a day, 365 days a year.

Follow Instructions Carefully—Kodak chemical packages have precautionary information on the labels. Always follow the label instructions. Read the Material Safety Data Sheets (MSDSs) for more handling information. If you need Material Safety Data Sheets for KODAK Chemicals in the U.S. or Canada, call (800) 242-2424, or ask your Kodak sales representative. Please supply the catalog (CAT) numbers for the chemicals when you request MSDSs. In other regions, contact Kodak in your country.

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

Label All Chemicals Properly—In the U.S., the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard requires employers to inform employees about hazardous chemicals in the workplace. This standard requires that all containers of hazardous chemicals, including processor tanks, be labeled. You can obtain KODAK Chemical labels for your processor tanks from your Kodak sales representative or you can order them from your Kodak price catalog (see the information in the "Chemicals" section). These labels give the chemical hazard, handling instructions, and the action to take in case of accidental contact. Use these labels *only* for KODAK Chemicals; use with other manufacturers' chemicals is an incorrect use under the OSHA standard. Other countries may have similar requirements, so check with local authorities or Kodak in your country.

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

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

Ventilate the Area Properly—Some photographic chemicals and solutions give off vapors or gases. For safety and comfort, keep the concentration of these vapors and gases to a minimum. To minimize the concentration of vapors and gases, provide good ventilation (about 10 changes of room air per hour). Also, keep the processing tanks enclosed and vent the dryer according to the manufacturer's specifications.

Working Tank Chemical Mixing / Processing Unit Storage

Working Tank Chemical Mixing

For the most current information, follow the mixing instructions on the package. Follow all safety precautions and handling recommendations given on the package and in *Safe Handling of Photographic Chemicals*.

Processing Unit Storage

Store SM *chemical concentrates* at 5 to 30°C (40° to 86°F) in a dry location. At temperatures lower than 5°C (40°F), parts may come out of solution or crystallize. Temperatures higher than 30°C (86°F) will accelerate chemical reactions and cause the concentrates to deteriorate. Be sure to properly rotate your inventory of SM Processing Units. Use the "Best-if-used-by" date on the outer case as a reference for rotating your inventory.

Compensating for Evaporation

When water evaporates from processing solutions, the chemical components remain and the solutions become overconcentrated. Evaporation occurs naturally to some degree, but it is more likely to occur when tank solutions are up to temperature, or when solutions are cooling down after shutdown. Follow the procedure described below as a guideline for compensating for evaporation. *Do not use cold water to top-off solutions.*

1. *At daily start-up*—With the recirculation system on, check the level of the tank solutions. If the tank solution level is not up to the top of the overflow tube, add water—at approximately operating temperature—to bring the solution level up to the top of the overflow tube. Some processors do this automatically when prompted.
2. *At shutdown*—Squirt the top edges of the tank, the top of the rack, and the rollers at the top of the rack lightly with warm water to avoid the buildup of dried chemicals. Do not use too much water to avoid severely diluting the tank solution. Clean and rinse crossovers thoroughly to minimize chemical buildup.

Clean Your Processor Tanks and Racks Regularly

Always wear splash-proof goggles, protective gloves and an apron when you clean racks and tanks.

Routine Cleaning—Follow the recommendations described below. **Be sure to follow your equipment manufacturer's recommendations for regular maintenance procedures**.

1. Remove crossovers, squeegee rollers, or squeegees daily at shutdown, and rinse them with hot water.
2. Once a week, remove each rack from the processor, clean it with hot water and a soft, non-abrasive brush, and rinse thoroughly. Inspect the racks for non-moving rollers, deformities in rollers, worn or broken springs, loose screws, deteriorated retaining clips, etc, to ensure smooth transport of film.
3. On a periodic basis (every 6 to 12 months), clean racks and tanks with a non-abrasive brush, and remove stains from racks and tank walls. Rinse racks and tanks thoroughly before you refill the tanks.

Removing Biological Growth from Tanks and Racks

Biological growth can occur in stabilizer tanks, and is a potential source of dirt. Check stabilizer tanks weekly, and clean if necessary. Wear protective gloves, an apron, and splash-proof goggles when you follow this procedure. To remove biological growth:

1. Empty the processing solution tank. Dispose of waste solutions according to local disposal regulations.
2. Rinse the tanks and racks with hot water; drain the rinse water and repeat.

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

Note: For more information on the recommended methods for cleaning processing tanks in the U.S., contact Kodak Service and Support at (866) 352-4367. In Canada, call (800) 465-6325. For information on controlling biological growth, request a copy of KODAK Publication CIS-3, *Biocides for Photographic Solution Tanks and Wash Water.*

Effluent Disposal

Disposing of processing effluent is an important operation of your minilab. Effluent from processes using FLEXICOLOR SM and EKTACOLOR SM Chemicals consists of developer and bleach solutions, as well as desilvered bleach-fix, fixer, and stabilizer solutions. This effluent is compatible with and can be effectively treated by a municipal secondary waste-water treatment plant.

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

After efficient silver recovery, the combined effluent from a minilab that is in control and using Processes C-41SM and RA-2SM has these characteristics:

pH	6.5 to 9
Temperature	Less than 30°C (90°F)
Silver	Less than 5 mg/L
Suspended solids	Less than 50 mg/L
Oils, greases, or detergents	None
Flammable, explosive, or toxic materials	None

Concentration of other materials depends on a number of factors. For more information on the composition of photographic solutions that you use, see the Material Safety Data Sheets or contact Kodak in your country.

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

- Use the correct replenishment rates and check them often
- Avoid making batch discharges, such as tank dumps
- Discharge processing effluent to your sewer slowly by trickling it in with normal non-processing effluent
- Desilver bleach-fix, fixer, and stabilizer overflow before you discharge it

Other Effluent Disposal Methods—Although most minilabs discharge their effluent to a municipal waste-treatment plant, restrictions or lack of access to a treatment plant may require some minilabs to use an off-site disposal service, such as the KODAK RELAY Program, for effluent disposal.

Off-Site Disposal—You can have your processing effluent removed by a licensed disposal company. The KODAK RELAY Program is a disposal service for customers who use Kodak photographic chemicals. It is offered in conjunction with the Safety-Kleen Corporation. You can participate in the RELAY Program to help you comply with waste-management regulations, especially when you cannot discharge processing effluent to a sewer.

The RELAY Program is currently available only throughout the continental United States and Puerto Rico. Canadian customers who need help with waste-management options can call (800) 465-6325; other customers can call (800) 242-2424.

To participate in the RELAY Program, contact your Kodak sales representative or call Kodak Environmental Services at (800) 242-2424.

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

Note: If you have specific environmental questions about FLEXICOLOR SM and EKTACOLOR SM Chemicals in the U.S., call the Kodak Information Center at (800) 242-2424. In Canada, call (800) 465-6325; in other regions, contact Kodak in your country.

Silver Recovery

Silver is a seasoning product of processing photographic films and papers. Sewer codes may limit the concentration of silver in effluent that may be discharged. To reduce the amount of silver in the effluent, you can desilver used fixer, bleach-fix, and stabilizer solutions with electrolytic silver-recovery cells and/or silver-recovery cartridges.

To increase electrolytic-silver recovery efficiency, adjust the pH of your bleach-fix solution to 7.5 to 8.0 before desilvering it.

Note: Use **one** of the chemicals in the following table to adjust the pH of the bleach-fix.

Chemical	To Adjust the pH to 7.5 to 8.0, Add to Each Litre of Bleach-Fix Overflow
28% Ammonium Hydroxide	10 mL
10N Sodium Hydroxide	13 mL
45% Potassium Hydroxide	14 mL
10% Sodium Carbonate	200 mL
10% Potassium Carbonate	300 mL

Operate your electrolytic-recovery cell according to the manufacturer's instructions. Use as long an operation time as possible. Adjust the amperage to get a firm brown plate. After efficient electrolytic silver recovery followed by two silver-recovery cartridges (in series), the silver concentration should be less than 5 mg/L. Discharge the desilvered effluent with other processing effluent.

For more information about silver recovery, see KODAK Publication No. J-212, *The Technology of Silver Recovery for Photographic Processing Facilities*, or visit the Kodak website at *www.kodak.com/go/kes*.

Solid Waste Recycling

Recycling Programs Offered Through Kodak

In the U.S., Kodak has established a series of recycling programs designed to help minilabs minimize the amount of solid waste that they send to landfills. These programs, administered by Kodak include—

- KODAK One-Time-Use Camera Recycling Program
- Paper Core Recycling Program

The terms and conditions of each program are different. For more information about these programs, contact your Kodak sales representative, or call the Kodak Information Center at (800) 242-2424 in the U.S.; in Canada, call (800) 465-6325. In other regions, contact Kodak in your country.

For additional information on waste prevention and Kodak recycling programs, refer to Kodak Publication J-412, *Waste Prevention and Recycling for Photographic Processing Facilities*, or visit the Kodak website at *www.kodak.com/go/kes*.

2 PROCESSING CYCLES

Processing Cycles for KODAK SM Chemicals

This section describes:

Processing cycles for KODAK FLEXICOLOR SM and EKTACOLOR SM Chemicals
including information on—

- Time and temperature
- Replenishment rates
- Filtration
- Drying

Film Processing Cycle for KODAK FLEXICOLOR SM Chemicals

The cycle for processing color negative films is Process C-41SM. Process C-41SM is recommended for processing all Kodak color negative films.

Replenishment rates given are for a typical mix of Kodak color negative films in 35 mm or 24 mm size. Use the rates as starting points; adjust them as required according to your control-plot results.

Table 2-1 Processing Steps and Conditions for Process C-41SM

Solution/Step	Time min/sec	Temperature °C (°F)	Replenishment Rate for Versions 2.0* and 2.1		Comments
			mL/m 35 mm	mL/m 24 mm	
Developer	3:15†	37.8 ± 0.15 (100 ± 0.25)	13.0		Recirculate and filter.
Part A			0.959	0.605	
Part B			0.120	0.076	
Part C			0.442	0.278	
Water			11.48	7.232	
Bleach	1:00‡	38 ± 3 (100 ± 5)	3.51	2.53	Recirculate and filter. Aerate with oil-free air.
Fixer	2.00‡§	38 ± 3 (100 ± 5)	15.1		Recirculate and filter.
Concentrate			7.55	5.44	
Water			7.55	5.44	
Final Rinse	1:00‡	38 ± 3 (100 ± 5)	27.3		Recirculate and filter.
Concentrate			0.483	0.304	
Water			26.8	16.88	
Dry	As needed	40 to 68 (104 to 155)	—	—	Check filter regularly.

* Replenishment rate information is for Version 2.0 SM Processing Units F1 and for Version 2.1 SM Processing Units F2 Make sure the latest version of software installed on the film processor is enabled for "V2.0".

† Immersion time plus crossover time into the bleach tank. The developer time range is 3:15 ± 0.01.

‡ Bleach, fixer, and stabilizer times are the minimum times in solution, and do not include crossover times. If necessary, you can use longer times for these solutions. For best results, keep crossover times to less than fifteen seconds.

§ The fixer requires two countercurrent-flow tanks with equal time in both tanks; the stabilizer requires three countercurrent-flow tanks with equal time in each tank.

Replenishment Rates—The replenishment rates given are starting-point recommendations for a typical mix of Kodak color negative films.

Developer—If needed, adjust the developer replenishment rate according to your control plots; *keep the ratios of A, C and developer water constant*—i.e., increase or decrease all parts by the same percentage. Your developer replenishment rate depends on:

- amount of the various types of film processed
- film exposure
- other variables of the processing system

Bleach—To maintain chemical concentrations and pH level, the bleach replenishment rate must be high enough to compensate for developer carryover into the bleach. The bleach replenishment rate given is for typical carryover rates. If the carryover rate is higher, leuco-cyan dye and/or retained silver may occur. To offset the higher carryover, increase the replenishment rate. See your equipment manual for specifications and adjustments for squeegees or squeegee rollers.

Fixer—Use a replenishment rate of 17 mL/135-24 roll. The rate should be adequate to offset dilution from the carryover of the bleach.

Final Rinse—Use a replenishment rate of 30 mL/135-24 roll.

Bleach Aeration—The bleach requires oxygen to return the exhausted bleaching agent to a usable form. Aeration provides oxygen by pumping air bubbles through the bleach. Not enough aeration can cause leuco-cyan dye and retained-silver problems, particularly with a diluted or underreplenished bleach.

Final Rinse—The final rinse uses no stabilizing agent for safer handling. It also contains a wetting agent to provide uniform drying.

Filtration—Small amounts of insoluble materials in the water and solutions can stick to the film and minilab tank walls and rollers. This dirt can damage film. Install filters recommended by the manufacturer of your minilab to remove these materials. Usually, filters with a porosity of 10 to 30 microns are effective for solutions and wash water, and filters with a porosity of 15 microns are effective for incoming water supplies. You can use the following filter materials with processes that use FLEXICOLOR SM Chemicals:

- bleached cotton
- cellulose with phenolic resin binder
- fiber glass with phenolic resin binder
- polypropylene
- spun polypropylene
- viscose-activated carbon

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

Drying—Keep the film-drying area clean and free of dirt. If the dryer has a filter, check it regularly. Ideally, the drying temperature should not exceed 68°C (155°F). If the film has excessive curl, the ambient conditions are too dry; increase the relative humidity.

Low Utilization—Utilization is a way of expressing how much of your processor's capacity is used. If your processor utilization is low, oxidation and evaporation will affect the activity of your processing solutions. Follow the recommendations provided in KODAK Publication CIS-246, *Operating Minilabs at Low Levels of Utilization: Process C-41 and RA-4.*

Paper Processing Cycle for KODAK EKTACOLOR SM Chemicals

The cycle for processing KODAK EKTACOLOR Edge and ROYAL Papers in SM Minilabs is Process RA-2SM. This process cycle is faster than the cycle for Process RA-4.

Table 2-2 Processing Steps and Conditions for Process RA-2SM

Solution/Step	Time* min:sec	Temperature °C (°F)	Replenishment Rate	Comments
			mL/m² (mL/ft²)	
Developer P1 Unit CAT 178 2713 Part A Part B Part C Water	0:25	40 ± 0.3 (104 ± 0.5)	64.6 (6.00)‡ 3.01 (0.28) 5.49 (0.51) 5.81 (0.54) 50.25 (4.67)	Recirculate and filter.
Developer V2.2 **New P1 Unit Version 2.2** **CAT 807 9782**† Part A Part B (not used)§ Part C Water	0:25	40 ± 0.3 (104 ± 0.5)	59.3 (5.5)‡ 3.01 (0.28) 0.01 (0.01)§ 5.81 (0.54) 50.25 (4.67)	Recirculate and filter.
Bleach-Fix V2.1 Part A Part B	0:25	35 to 41 (95 to 104)	26.4 (2.45) 10.8 (1.00) 15.6 (1.45)	Recirculate and filter.
Stabilizer Concentrate Water	1:30¶	35 to 41 (95 to 104)	193.7 (18.00) 1.49 (0.138) 192.2 (17.86)	Recirculate and filter.
Dry	As needed	Not over 96 (205)	—	

* Immersion time plus crossover time to the next tank. The developer time range is 24 to 28 seconds. Minimum time for other solutions is minus one second from the normal times. Longer than normal times should have no adverse effects. For best results, a minimum of 22 seconds of solution time and crossover times of three seconds or less is recommended.

† **Please use up all older SM Processing Units P1 before converting to V 2.2.**

‡ The developer replenishment rate is a starting-point recommendation. You can adjust this rate as needed; *keep the ratios of A:B:C constant*.

§ EKTACOLOR SM Processing Unit P1, V 2.2 uses a single-part developer. Only the replenishment pumps for Part A and C are used. The Part B pump is not used. Although it does not matter what replenishment rate setting is used for the Part B replenishment pump, it is best to change this to the minimum setting the software will allow, 0.01.

¶ Four stabilizer tanks plumbed for countercurrent flow with each tank filtered.

Replenishment Rates—These rates are starting-point recommendations. Your replenishment rates will depend on:

- type of paper processed
- other variables of the processing system
- exposure level of the paper

Developer—If necessary, adjust the replenishment rate according to your control plots; *keep the ratios of Parts A, C, and Developer water constant.*

Bleach-Fix—The bleach-fix replenishment rates assume minimum carryover. If developer carryover is greater than normal, increase the bleach-fix replenishment rate to maintain the bleach-fix chemical balance and pH level; *keep the ratios of A:B constant.* Otherwise, problems such as retained silver may occur. See your equipment manual for specifications and adjustments for squeegee rollers.

Filtration—Processing solutions and wash water may contain some insoluble materials. If these materials aren't filtered out, they can stick to the paper, tank walls, rollers, and lines, and possibly damage the paper. Use filters recommended by the manufacturer of your minilab and change them regularly as a part of routine maintenance. Usually, filters with a porosity of 10 to 30 microns are effective for solutions and wash water, and filters with a porosity of 15 microns are effective for incoming water supplies. For more information about filters, see page 2-2.

Drying—The maximum drying temperature for KODAK EKTACOLOR Edge Paper and EKTACOLOR ROYAL Digital Paper is 93°C (200°F).

Low Utilization—Utilization is a way of expressing how much of your processor's capacity is used. If your processor utilization is low, oxidation and evaporation will affect the activity of your processing solutions. Follow the recommendations provided in KODAK Publication CIS-246, *Operating Minilabs at Low Levels of Utilization: Process C-41 and RA-4.*

3 PROCESS MONITORING AND TROUBLESHOOTING

Process Monitoring

This section describes

- Terms used in process monitoring
- How to use control strips
- Troubleshooting your process

If you use the correct replenishment rates for the process cycles, your processes should plot in control, and your minilab will produce high-quality customer orders—provided that your printer is set correctly. Deviations from standard conditions in the processing solutions, time, temperature, agitation, replenishment, filtration, or drying can cause processing problems.

Deviations from normal conditions produce either under- or overdevelopment.

- *Underdevelopment* in the film or paper process will result in a decrease in density in your control strips for your film or paper process. It may also produce a color shift, depending on the cause of the problem.
- *Overdevelopment* will produce an increase in density in your control strips. It may also produce a color shift, depending on the cause of the problem.

When the control plot shows a problem, you may also see the problem in customer orders. However, remember that customer orders reflect the entire system—i.e., the film process, paper process, and printer settings. For example, too much activity in the film process (overdevelopment of negatives), too little activity in the paper process (underdevelopment of prints), an incorrect printer setting, or a combination of these factors may cause the prints to be light. Checking only the control plots may not always isolate the problem, because using the wrong control strip or improperly stored strips may give false information. Therefore, to find the cause of any problem, check the control plots of your film and paper processes and the quality of customer orders.

Contamination Can Ruin a Process—Dirt and contamination can reduce the life and photographic quality of processing solutions. Avoid conditions where solutions can come in contact with other chemicals. Developers are especially sensitive to contamination. Small amounts of bleach, fixer, or bleach-fix solution can contaminate developer solutions and cause adverse photographic effects. Be careful not to drip solution into other tanks when you remove racks for cleaning. Wash and rinse processing and mixing equipment thoroughly before reusing it. The most common causes of contamination are—

- solution splashed or dripped into another solution
- pipes and tanks made of materials that react with the chemicals

Process Monitoring Terms

The following terms are frequently used in process monitoring.

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

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

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

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

Control Strips—Precisely exposed strips used to monitor your process.

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

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

Tolerances and Limits—These are density variations permitted before you must take corrective action. These tolerances and limits include an aim-value adjustment tolerance and action and control limits. See page 3-2 for more information on limits and adjustment tolerances.

Table 3-1 Tolerances and Limits for KODAK Control Strips, Process C-41SM

Measurement	Aim-Value Adjustment Tolerance	Action Limits	Control Limits	Color-Balance Spread Limit
D-min	+ 0.03	+ 0.05	+ 0.07	NA
LD	± 0.04	± 0.08	± 0.10	NA
HD – LD	± 0.03	± 0.08	± 0.10	0.09
$D\text{-max}_B - Y_B$	± 0.07	+ 0.10	+ 0.12	NA

NA = Not Applicable

Table 3-2 Tolerances and Limits for KODAK Control Strips, Process RA-2SM

Measurement	Aim-Value Adjustment Tolerance	Action Limits	Control Limits
D-min	—	—	+ 0.02
LD	± 0.04	± 0.10	± 0.12
HD – LD	± 0.03	± 0.10	± 0.12
BP	± 0.05	- 0.10	- 0.15

Process Monitoring Methods

To begin process monitoring you will need—

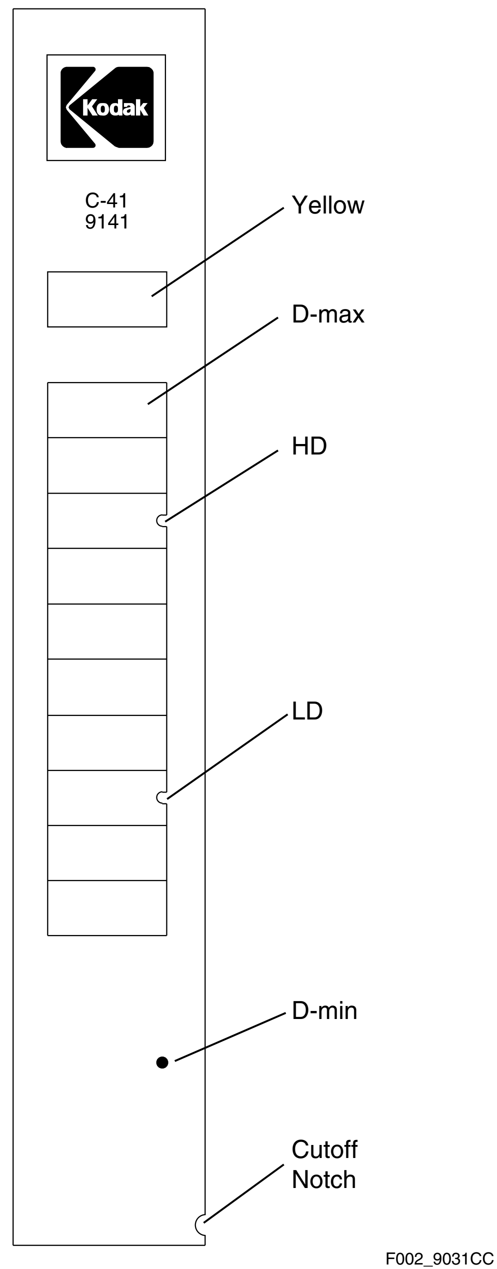
- KODAK Control Strips, Process C-41
- KODAK Control Strips, Process RA-4
- An electronic densitometer equipped with Status M filters to read the film-process control strips and Status A filters to read the paper-process control strips
- KODAK Process Record Form Y-55 or similar graph paper
- Red, green, and blue pencils

Control Strips

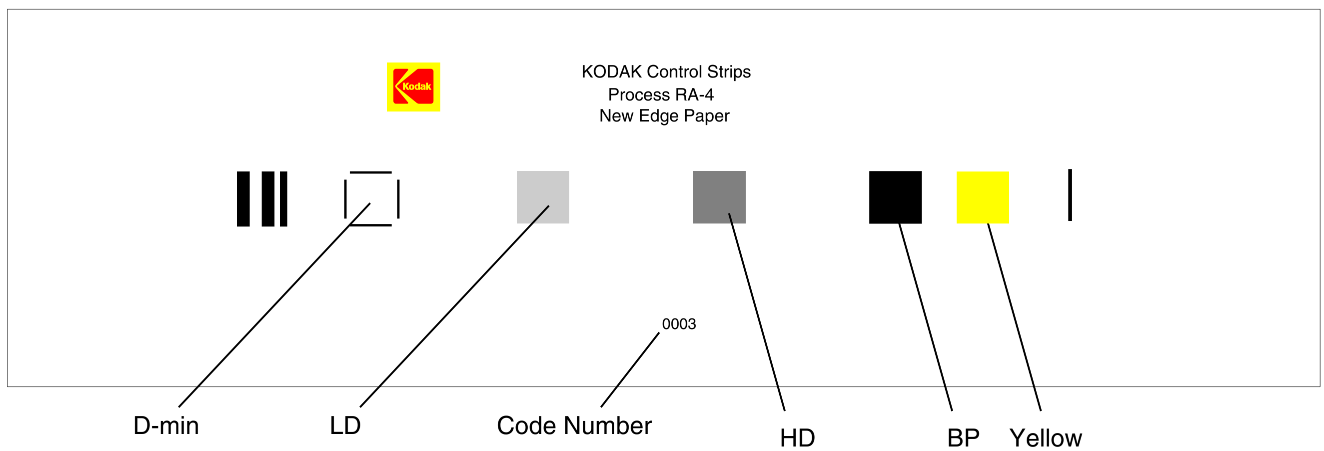
KODAK Control Strips are the Basic Control Material

KODAK Control Strips are available for monitoring your processes. For your SM film process, use KODAK Control Strips, Process C-41. For your SM paper process, use KODAK Control Strips, Process RA-4. A pre-processed reference strip is packaged with each type of control strip.

KODAK Control Strips, Process C-41 (35 mm)— Available in 100-foot rolls of approximately 120 strips with cutoff notches at 9 ½-inch intervals. The rolls are wound *emulsion side* in, with the D-min end of the density scale toward the outer end of the roll. Each strip contains 12 steps.



KODAK Control Strips, Process RA-4—Use these strips to monitor Process RA-2SM. They are available in moisture-resistant envelopes that contain five strips each, and come in boxes containing 25 or 50 strips. Each control strip, reference strip, and box label is marked with a code number. The code number identifies the strips as part of a particular batch. Each box contains correction factors for that particular code number. Use these factors to calculate the aim values for this batch of strips. Each strip contains five patches; measure four of them to obtain the density values for LD (low density), HD (high density), BP (black patch), and D-min (unexposed area). Use the yellow patch as a visual indicator of retained silver caused by low bleach-fix activity. When retained silver is present, the yellow patch will appear brown and less saturated than normal.



F002_9087BC

Storing, Handling, and Processing Control Strips

Store unused KODAK Control Strips, Process C-41, in refrigerated storage at a temperature between 4° to 13°C (40° to 55°F). Do not freeze unused C-41 control strips. Store unused KODAK Control Strips, Process RA-4, in frozen storage at a temperature of -18°C (0°F). Handle the unprocessed strips in total darkness. Remove only a day's supply from one package at a time; reseal and return the package to the freezer as quickly as possible. (Do not keep the package out of the cold storage for more than 1 hour per day.) Store your daily supply of control strips in a lighttight container at room temperature. At the end of the day, discard any unprocessed strips that you removed from storage.

Handle control strips by the edges to prevent fingerprints and surface damage. If film sticking, static marking, or moisture mottle occurs, allow the strips to warm up to room temperature before you process them.

Store the reference strip in its envelope when you are not using it.

Important

When beginning a new box of KODAK Control Strips, Process RA-4, allow the reference strip to warm up to room temperature before you remove it from its envelope (about 15 minutes). Exposing a frozen RA-4 reference strip to warm, moist air can cause low readings, particularly in the higher-density patches. If this occurs, wash the reference strip in warm water to return the readings to normal values.

Processing Control Strips

Each time you process a control strip, position it in the same location in your processor. When you process KODAK Control Strips, Process C-41, be sure that the D-min end of the strip enters the processor first. Process a control strip—

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

Plotting Control-Strip Densities

You can create a control chart for process monitoring by using the KODAK Process Record Form Y-55, or by easy-to-use computer programs such as KODAK KODALINK Service (see your Kodak representative for further information). If you are using the KODAK Process Record Form Y-55 or similar graph paper, follow the procedure given below.

1. Draw in the action and control limits given in Table 3-1 for Process C-41SM or in Table 3-2 for Process RA-2SM. Use black for the action limits and red for the control limits.
2. Remove the reference strip from the box of control strips. If you removed the box from cold storage, allow the reference strip to warm up to room temperature before you remove it from its envelope (about 15 minutes). Exposing a frozen Process RA-4 reference strip to warm, moist air can cause low readings, particularly in the higher density patches.
3. Measure the red, green, and blue densities in the center of each patch with a precision electronic densitometer. Do not move the strip as you make the density readings or you may affect the precision and repeatability of the measurements.

   If you have several boxes of strips with the same code number, average the readings of all the reference strips. A code number on the box label and the reference and control strips identifies each batch.

   For the film process, measure the densities of the reference strips listed in Table 3-3. Set your densitometer to the transmission mode, and use the Status M filters.

Table 3-3 Measurements for Control Strips and Reference Strips

Measurement	Step	Filter
D-min	clear area next to black dot	red, green, blue
LD	notched step closest to D-min	red, green, blue
HD	notched step closest to D-max	red, green, blue
D-max$_B$	maximum density patch	blue
Y_B	yellow patch	blue

For the paper process, measure the following densities of the reference strip. Set your densitometer to the reflection mode, and use the Status A filters.

Measurement	Step	Filter
D-min	unexposed patch	red, green, blue
LD	low density	red, green, blue
HD	high density	red, green, blue
BP	black	red, green, blue

4. To calculate aim values, apply the correction factors supplied in the instruction sheet packaged with each box of control strips to the reference-strip densities. If you averaged the reference-strip readings from several boxes of the same code number, apply the correction factors to the average. These corrected density values are the aim values for that batch of control strips. Record them in the proper spaces in the left margin of Form Y-55.
   - To obtain the HD – LD aim values, subtract the adjusted LD values from the adjusted HD values.
   - For the film process, subtract the blue-filter density of the yellow patch from the blue-filter density of the D-max patch to obtain the D-max$_B$ – Y_B value.
5. Process a control strip and measure the same patches that you measured in step 3.
6. Calculate the variations from aim by subtracting the aim densities from your control-strip densities. Plot the variations on your control chart.
   - Plot differences that are **larger** than the corresponding aim values (+ values) **above** the aim line.
   - Plot differences that are **smaller** than the corresponding aim values (– values) **below** the aim line.
7. If any of the variations from aim plot beyond the action or control limits, process another control strip. If the second strip confirms the results of the first strip, determine the cause of the problem. The information on page 3-7 will help you troubleshoot your process problems.
8. Whenever you take corrective action, process another control strip to confirm that the change you made returned the process to control before you resume normal processing.

Changing to a New Batch of Control Strips

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

1. While you still have a week's supply of control strips of the current code, process one control strip from the new batch of strips with one strip from the current batch *in three separate runs.*
2. Read and record the densities of the processed strips.
3. Determine aim values for the new batch of control strips; follow steps 2 through 4 on pages 3-4 and 3-5.
4. For your current batch of strips, calculate the variations from aim by subtracting your current aim densities from the densities of the three strips. Plot the variations on your control chart.
5. For the new batch of strips, calculate the variations from aim by subtracting the new aim densities (calculated in step 3) from the densities of the three strips. Plot the variations on your control chart.
6. Calculate the differences between the variations from aim of the current strips and the new strips. Average these differences, and then divide the result by 2.
7. Depending on the sign of the difference, adjust the aim values for the new batch of strips by adding or subtracting the results from step 6. The amount of the adjustment should not exceed the aim-value adjustment tolerances given in the appropriate table on page 3-2. If the adjustment is greater than the tolerance, determine the cause. Check your calculations, densitometer, and control strips.
8. Record the new aim values and the code number of the new batch of strips on your control chart, and begin using the new strips.

Troubleshooting

When one or more process parameters exceeds the control limits, stop processing customer work until you find and correct the cause of the problem. It is important to become familiar with control-chart patterns and cause-and-effect relationships. Control-chart patterns can generally be separated into three categories.

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

- Developer temperature that is too high
- Developer time that is too long
- Overreplenished developer (i.e., the solution is replenished at a rate that is too high) or improper proportion of developer concentrate delivery
- Fresh tank (start-up only)
- Developer contamination

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

- Developer temperature that is too low
- Developer time that is too short
- Underreplenished developer (i.e., the solution is replenished at a rate that is too low) or improper proportion of developer concentrate delivery
- Fresh tank (start-up only)
- Developer tank solution diluted with water
- Developer contamination

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

- Developer oxidation caused by excessive aeration
- Developer contamination
- Bleach underreplenishment
- Fixer too dilute or underreplenished
- Contaminated stabilizer (paper only)

Check your control chart to determine if the process drifted out of control slowly or suddenly.

Slow Drift—An out-of-control condition that has occurred slowly over a long period signals a problem such as:

Improper replenishment—caused by a replenishment rate that is not set correctly or a defective replenisher pump.

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

Evaporation or oxidation—caused by low utilization or air drawn into the processing solutions by a bad pump or a poorly placed ventilator fan.

Sudden Change—Causes of a sudden out-of-control condition are:

Control strip—using a control strip with a different code number or a strip that has not been properly stored or light-fogged can indicate a sudden process change.

Densitometer—if your densitometer is not working properly or is out of calibration, the density readings will be wrong. This can falsely signal that there was a process change.

Time or temperature—check that the time and temperature were set correctly, particularly if it is easy for operators to accidentally change the settings.

Contamination—very small amounts of fixer or bleach-fix can contaminate the developer tank solution and cause a large density and color shift.

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

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

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

Daily Processing Log

Use a daily processing log for your film and paper processors. A processing log will provide you with a convenient means of keeping track of the amount of film and paper you process, and can provide you with valuable information in case of process and/or machine problems.

4 CONTROL-CHART EXAMPLES

The following charts are examples of how various conditions will affect your control plots. They are intended *only as a guide;* your plot may not look exactly like these examples. Your plot may be different because of processor and control-strip differences, and your processing conditions. More than one problem may also be affecting your process.

These plots are typical for a particular problem; however, if they do not exactly match your plot, find the one that most closely matches the predominant trend. Use these charts to analyze process problems.

Chart	Solution	Condition
Process C-41SM		
1	Developer	Temperature Too Low/High
2	Developer	Time Too Short/Long
3	Developer	Agitation Too Low/High
4	Developer	Replenishment Rate Error / Part A—Too Low/High
5	Developer	Replenishment Rate Error / Part B—Too Low/High
6	Developer	Replenishment Rate Error / Part C—Too Low/High
7	Developer	Replenishment Rate Error / Water—Too Low/High
8	Developer	Replenishment Rates Too Low/High
9	Developer	Oxidation
10	Developer	Contaminated with Bleach
11	Developer	Contaminated with Fixer
12	Bleach	Replenishment Rate Too Low/High
13	Bleach	Poor Aeration
14	Fixer	Underreplenished / Dilute
Process RA-2SM		
15	Developer	Temperature Too Low/High
16	Developer	Replenishment Rate Error / Water—Too Low/High
17	Developer	Replenishment Rates Too Low/High
18	Developer	Contaminated with Bleach-Fix
19	Developer	Oxidation

Process C-41SM

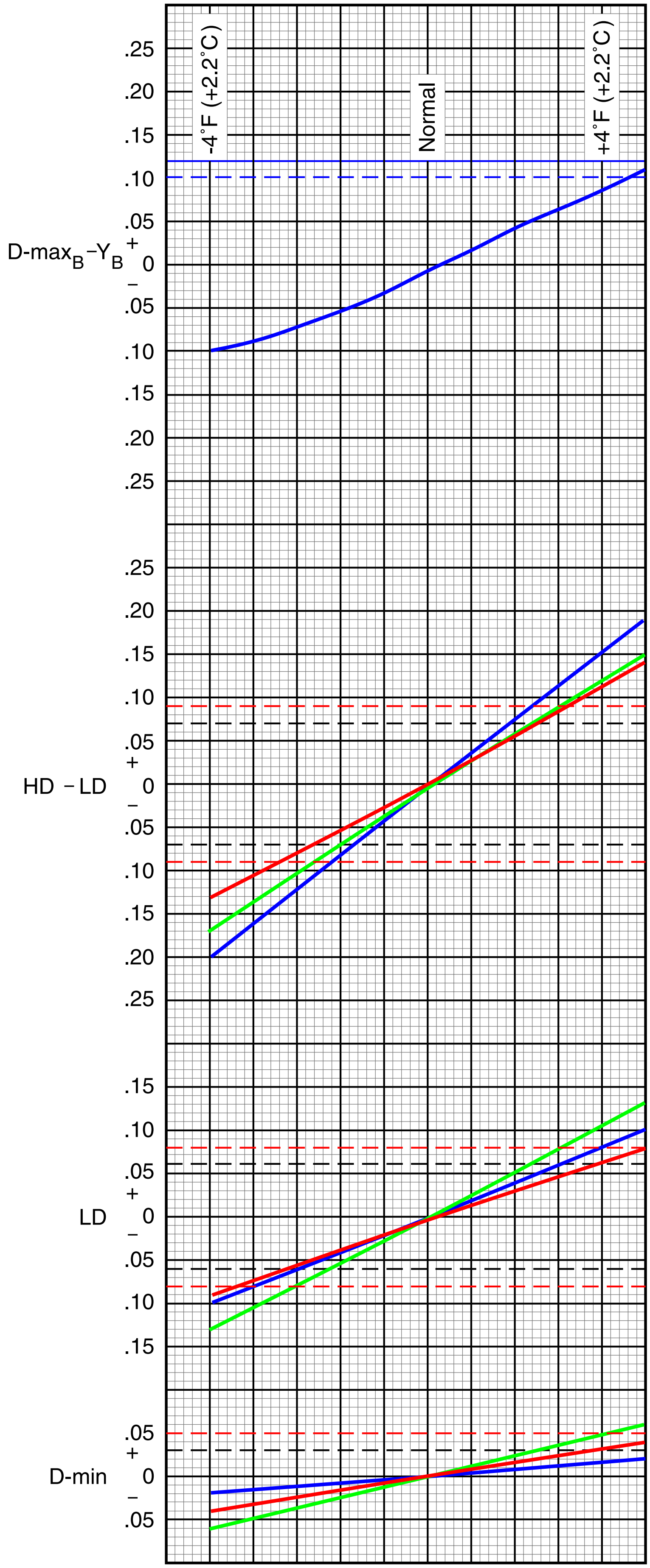
Developer Temperature Too Low/High

The recommended developer temperature for Process C-41SM is 37.8 ± 0.15°C (100 ± 0.25°F). Developer activity varies directly with temperature. A developer temperature that is too high or too low affects development and the amount of dye formed. If the developer temperature is too high, the density values will plot higher than normal; if the developer temperature it too low, the density values will plot lower than normal.

Out-of-control conditions due to temperature changes are difficult to solve. They can appear and disappear rapidly because they are usually caused by intermittent electrical problems. Poor tank recirculation can also cause temperature problems; check that the developer recirculation filter is not clogged, and replace the filter if needed.

Check the developer temperature with an accurate thermometer frequently, and adjust it as needed.

Chart 1



Process C-41SM

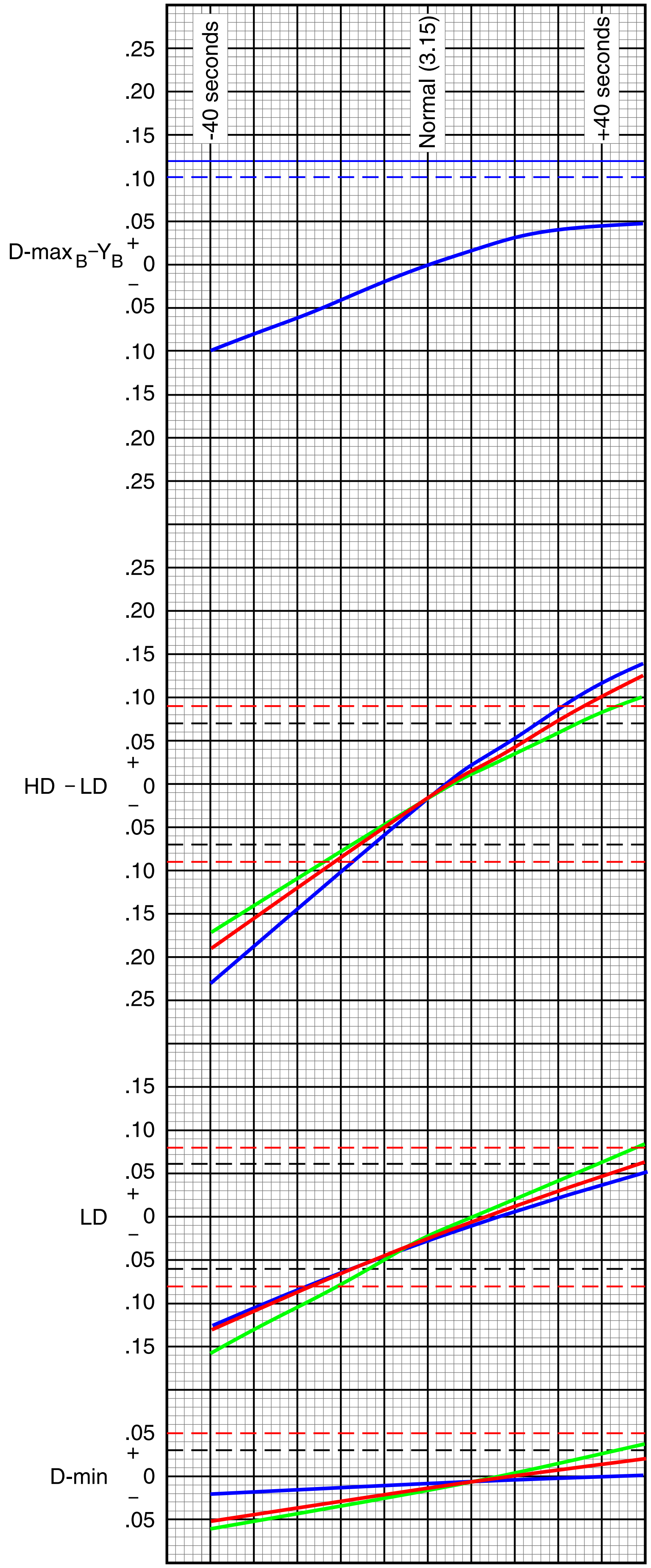
Developer
Time Too Short/Long

Developer activity varies directly with time. An increase in developer time produces an increase in the amount of dye formed; a decrease in developer time produces a decrease in the amount of dye formed.

Developer-time variations can occur in processors because of electrical-load variations and motor-temperature differences from a cold start to equilibrium. Electrical-load differences can be caused by other equipment (e.g., a heater) on the same power line. In some cases, you may need a voltage regulator on the drive motor to compensate for external voltage variations.

Mechanical problems, such as misaligned moving parts, can cause developer-time problems. Be sure that the transport is functioning properly. Use a stopwatch to measure the developer time, and compare it with the machine setting.

Chart 2



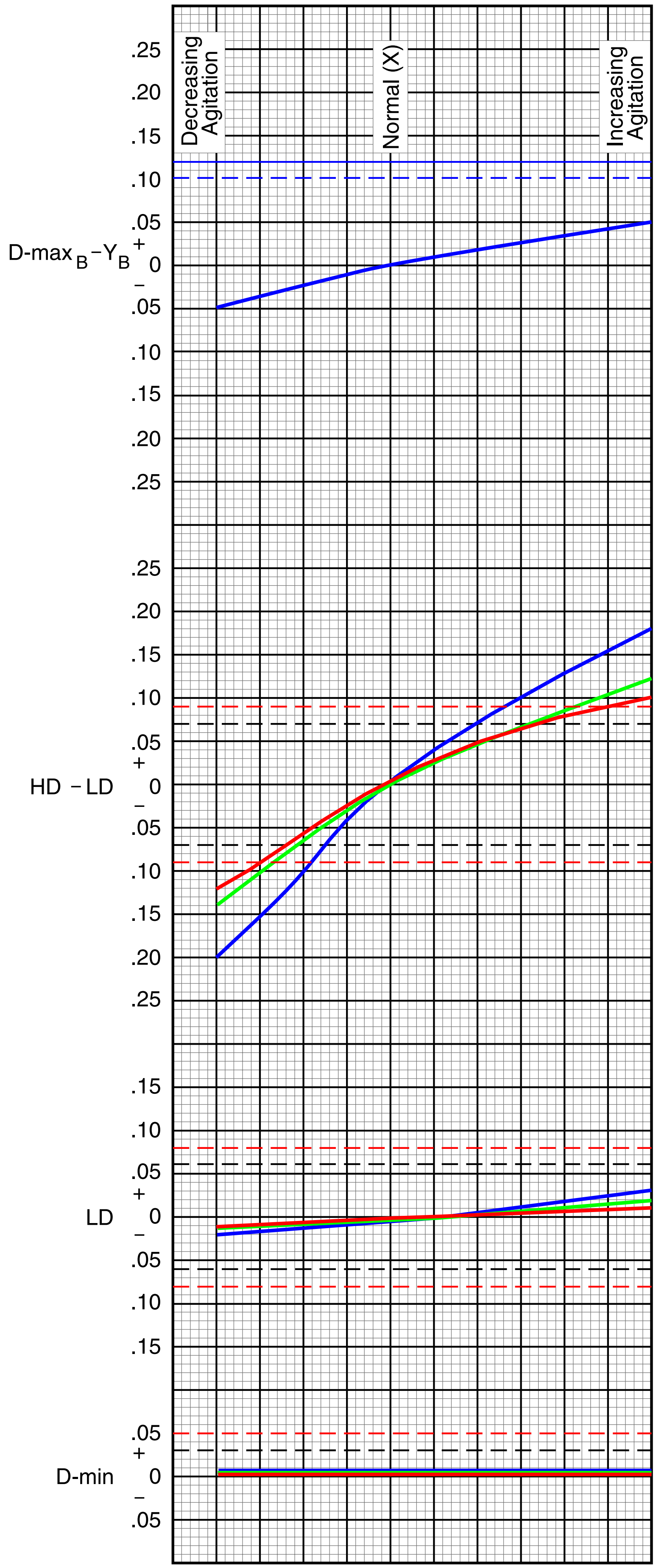
Process C-41SM

Developer
Agitation Too Low/High

Agitation aids in removing developer by-products from the film so that fresh developer can diffuse into the emulsion. An increase in agitation increases the amount of dye formed. Poor agitation does not allow enough development, resulting in low and non-uniform densities. Fluctuations in agitation have the greatest effect on high densities.

Agitation is provided by a recirculation system. A kinked recirculation line or a plugged slot nozzle can hinder agitation causing underdevelopment. Also check the recirculation pumps to be sure they are working within specifications set by the manufacturer.

Chart 3



Process C-41SM

Developer Replenishment Rate / Part A Too Low/High

Developer activity varies with the delivery of Part A to the developer tank. Overreplenishment results in high activity; underreplenishment results in low activity.

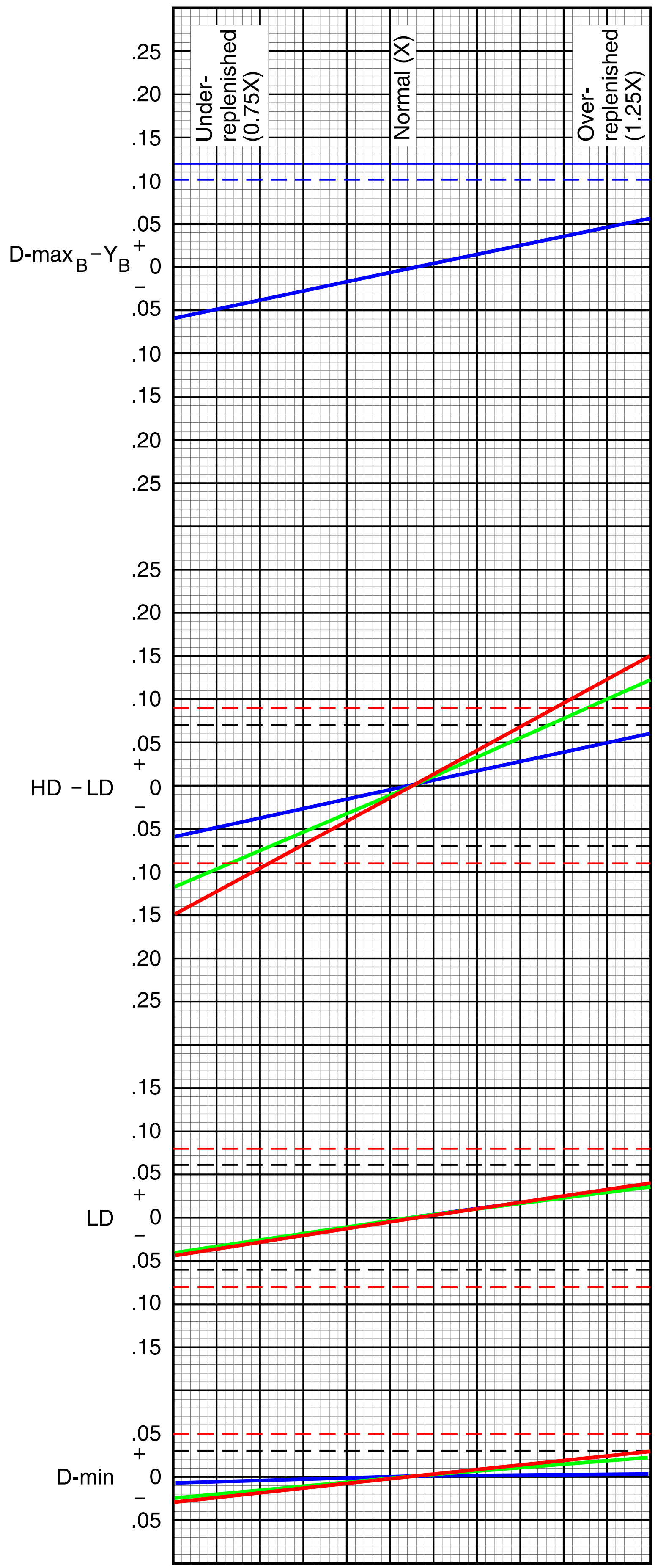
How quickly your control plots change depends on the variation from aim of your replenishment delivery and the amount of film processed.

Check the Part A cube after you replace the F1 Processing Unit; if there is substantial solution remaining in the cube, this indicates that the rate is incorrect.

If the Part A delivery is suspect—

- Check the developer replenishment pump fitting for Part A to be sure it is snug.
- Check the delivery lines for air. This is an indication that the pump valves have failed.
- Check the pump calibration.
- Check the replenishment rate setting.
- Update the pump values in your processor software.

Chart 4



Process C-41SM

Developer Replenishment Rate / Part B Too Low/High

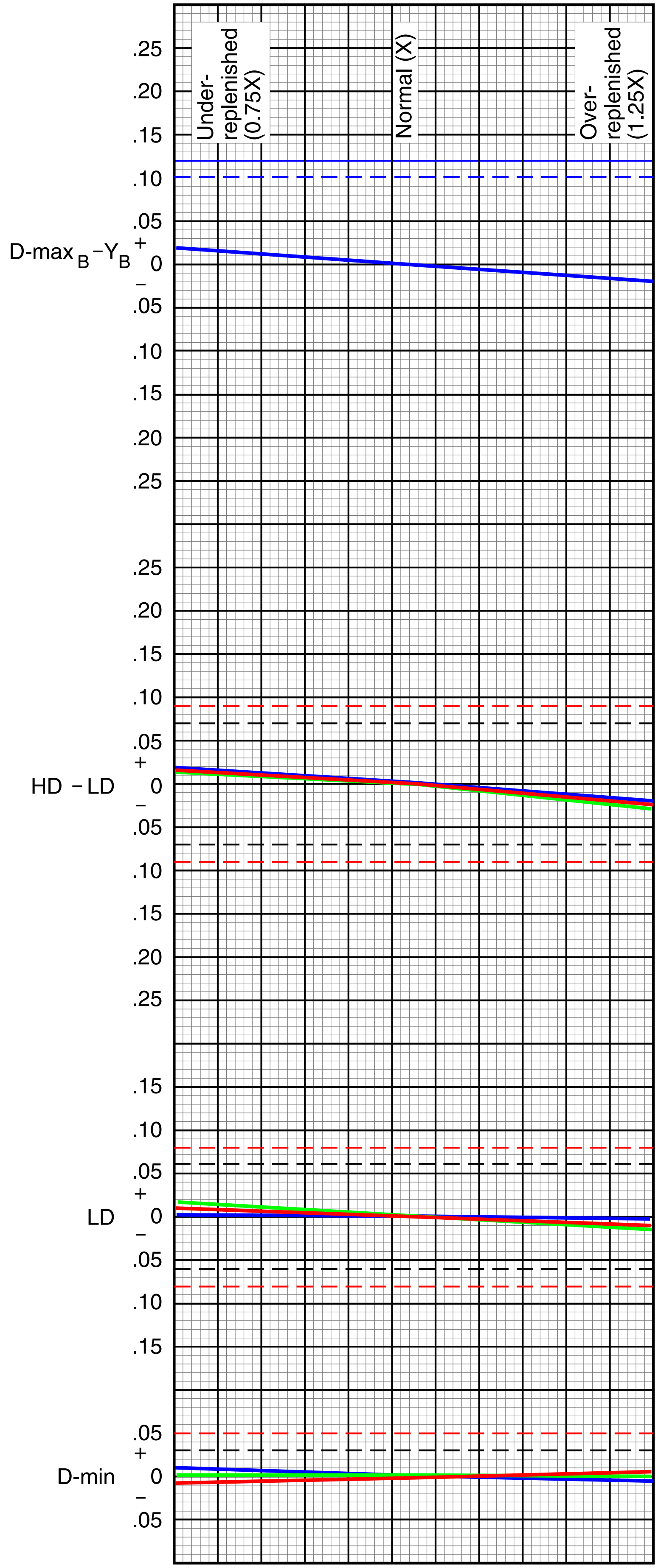
Developer activity varies only slightly with a variation in the delivery of Part B to the developer tank. Over time, however, it will affect the oxidation protection of the developer; see Chart 9.

Check the Part B cube after you replace the F1 Processing Unit; if there is substantial solution remaining in the cube, this indicates that the rate is incorrect.

If the Part B delivery is suspect—

- Check the developer replenishment pump fitting for Part B to be sure it is snug.
- Check the delivery lines for air. This is an indication that the pump valves have failed.
- Check the pump calibration.
- Check the replenishment rate setting.
- Update the pump values in your processor software.

Chart 5



Process C-41SM

Developer Replenishment Rate / Part C Too Low/High

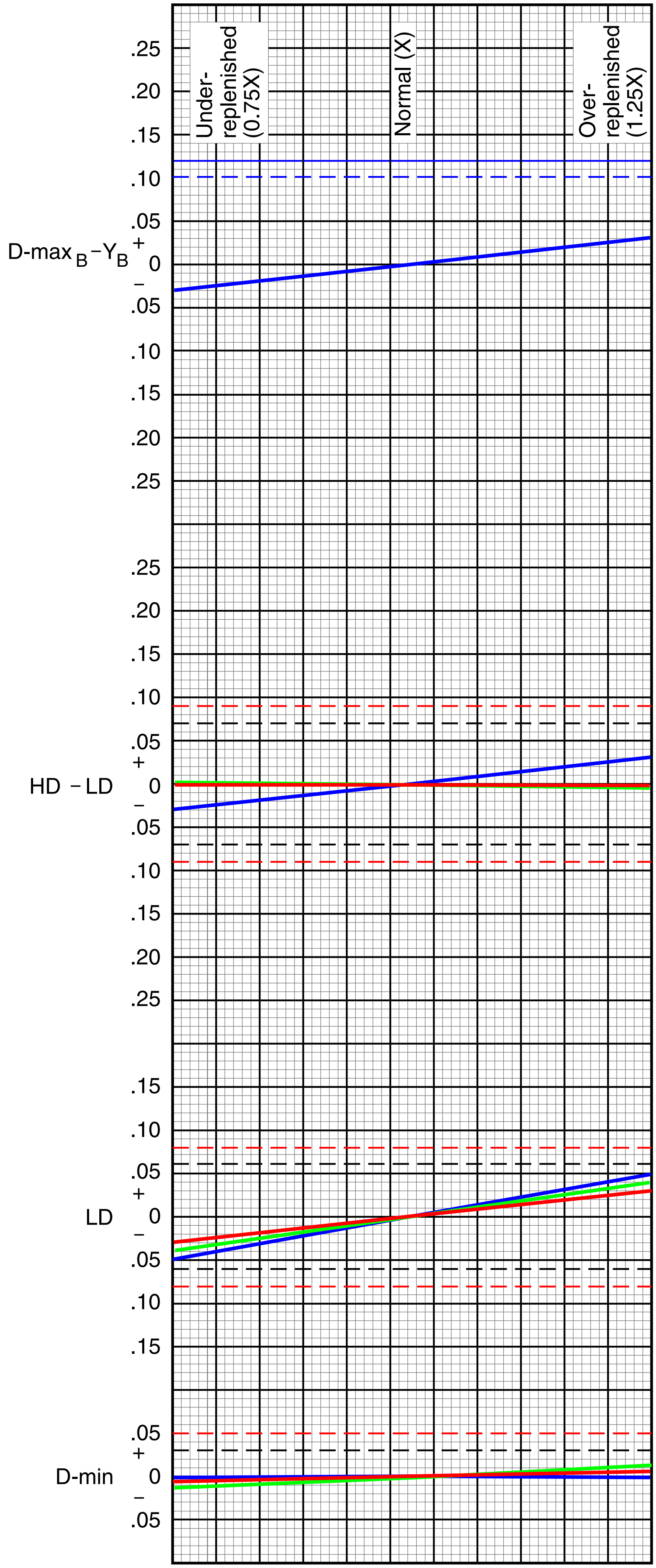
You will notice developer activity variation caused by the delivery of Part C to the developer tank first in the LD parameter; LD will increase with overreplenishment and decrease with underreplenishment.

Check the Part C cube after you replace the F1 Processing Unit; if there is substantial solution remaining in the cube, this indicates that the rate is incorrect.

If the Part C delivery is suspect—

- Check the developer replenishment pump fitting for Part C to be sure it is snug.
- Check the delivery lines for air. This is an indication that the pump valves have failed.
- Check the pump calibration.
- Check the replenishment rate setting.
- Update the pump values in your processor software.

Chart 6



Process C-41SM

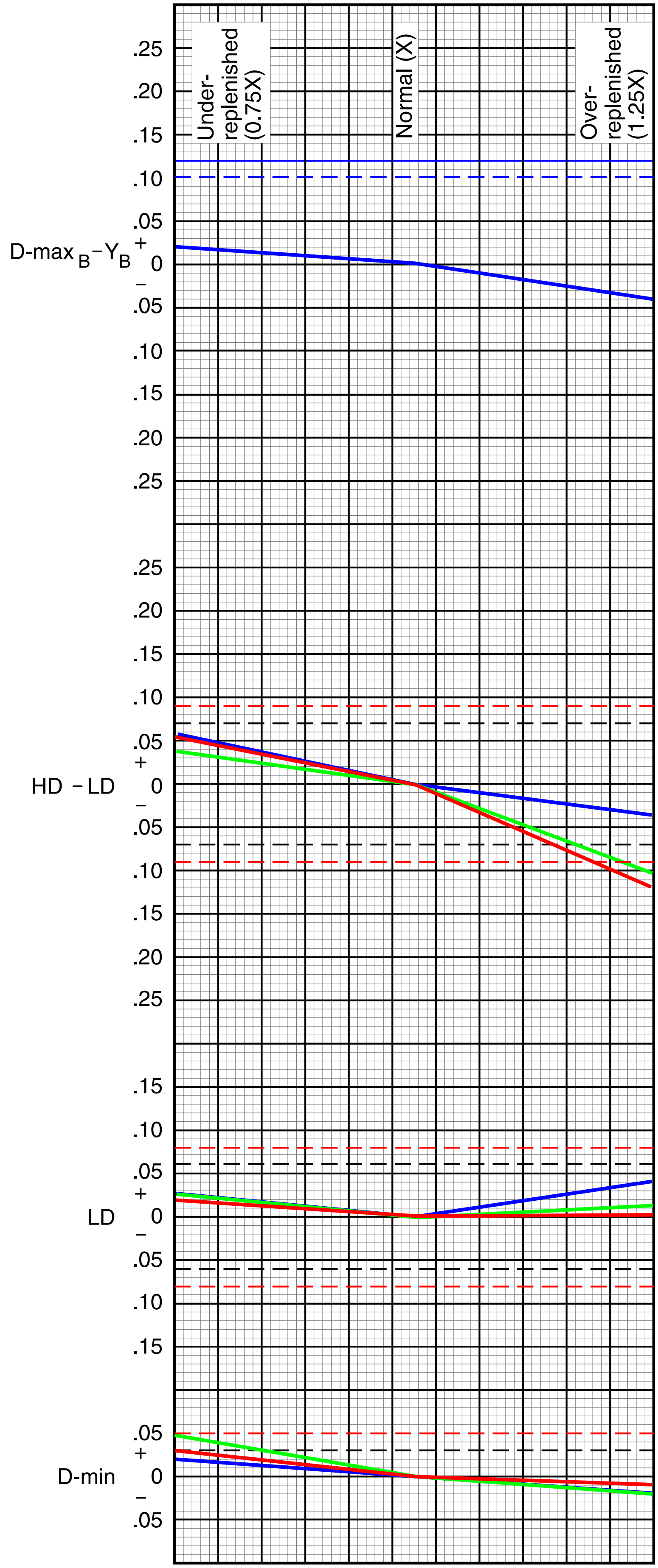
Developer Replenishment Rate / Water Too Low/High

Developer activity varies with the delivery of water to the developer tank because the working tank solution becomes overconcentrated or diluted. For contrast (the HD – LD parameter), the activity varies inversely with the amount of water, decreasing with too much water and increasing with too little water. However, the speed (or LD parameter) increases with too much or too little water.

If the water delivery is suspect—

- Check the developer replenishment pump fitting for water to be sure it is snug.
- Check the delivery lines for air. This is an indication that the pump valves have failed.
- Check the pump calibration.
- Check the replenishment rate setting.
- Update the pump values in your processor software.

Chart 7



Process C-41SM

Developer Replenishment Rates Too Low/High

Developer replenishment rates (A:B:C:water) directly affect developer activity. An overreplenished developer will produce high dye densities; an underreplenished developer will produce low dye densities. You will see the effects of over- and underreplenishment in all of the control-plot densities. The amount of change that you see in the plot as a result of incorrect replenishment depends on the developer-tank volume, processor speed, and the amount and type of film processed. If incorrect replenishment appears to be the problem, check that the replenishment system is operating properly and is correctly calibrated.

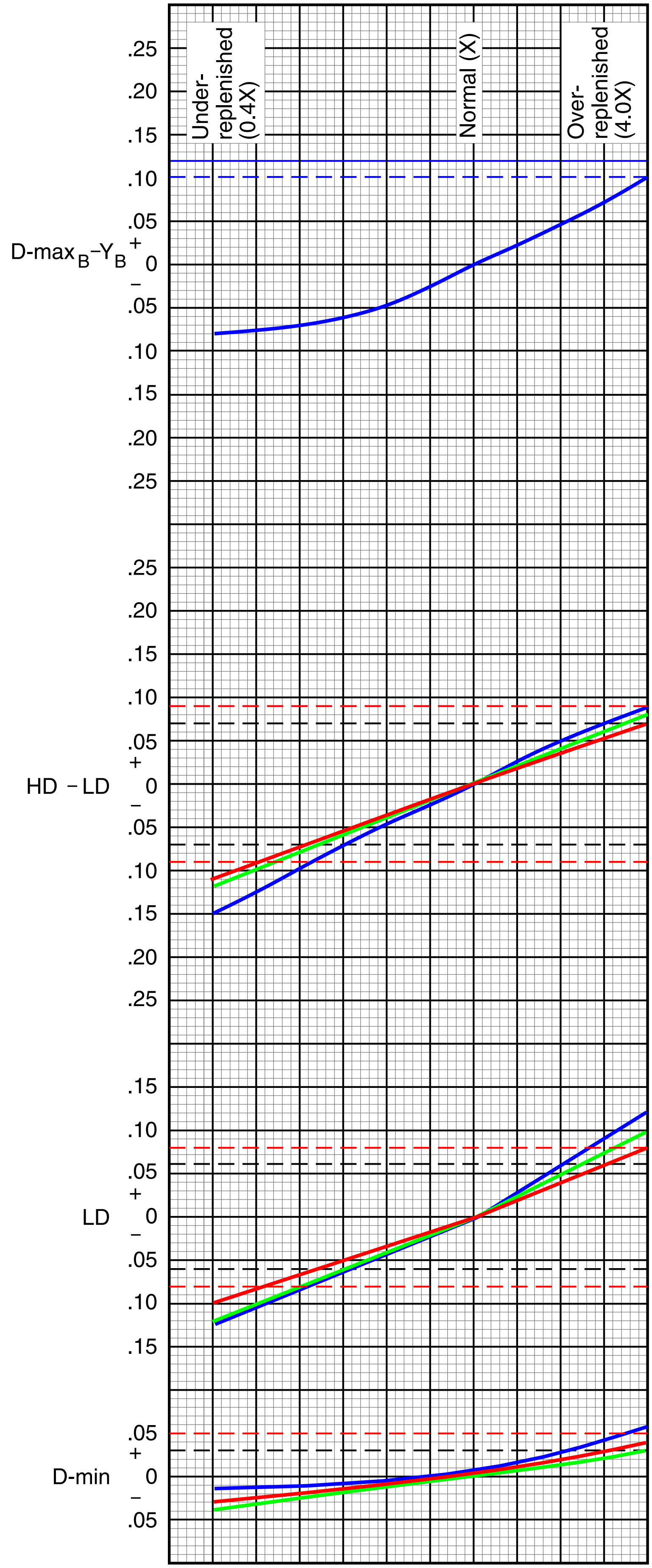
The recommended replenishment rates are *starting points only.* Exact rates depend on the types of film you process, their average densities, and how well you maintain operating conditions, such as development time and temperature. In general, higher speed films (especially ISO 400 and higher) require higher developer replenishment rates. Some private-label films and other manufacturers' films also require slightly higher developer replenishment rates. If you process more of these films, you may need to increase your developer replenishment rates by 10 to 15 percent from the starting point. Determine your exact rates by monitoring the process with control strips and adjusting the rates as needed according to the control plot. However, do not adjust the rates to "chase" small changes in the control plot. **Changing rates should be done proportionately with all developer parts, including water**.

To avoid replenishment problems, check the replenisher settings regularly to be sure that the correct rates are maintained.

If you suspect that replenishment is the problem:

- Check that the replenishment system is set correctly.
- Verify that the replenishment pumps are all operating.
- Verify that the replenishment pumps are producing the correct output.
- If the processor has been idle, verify that the "J" tubes are full of solution.

Chart 8



Process C-41SM

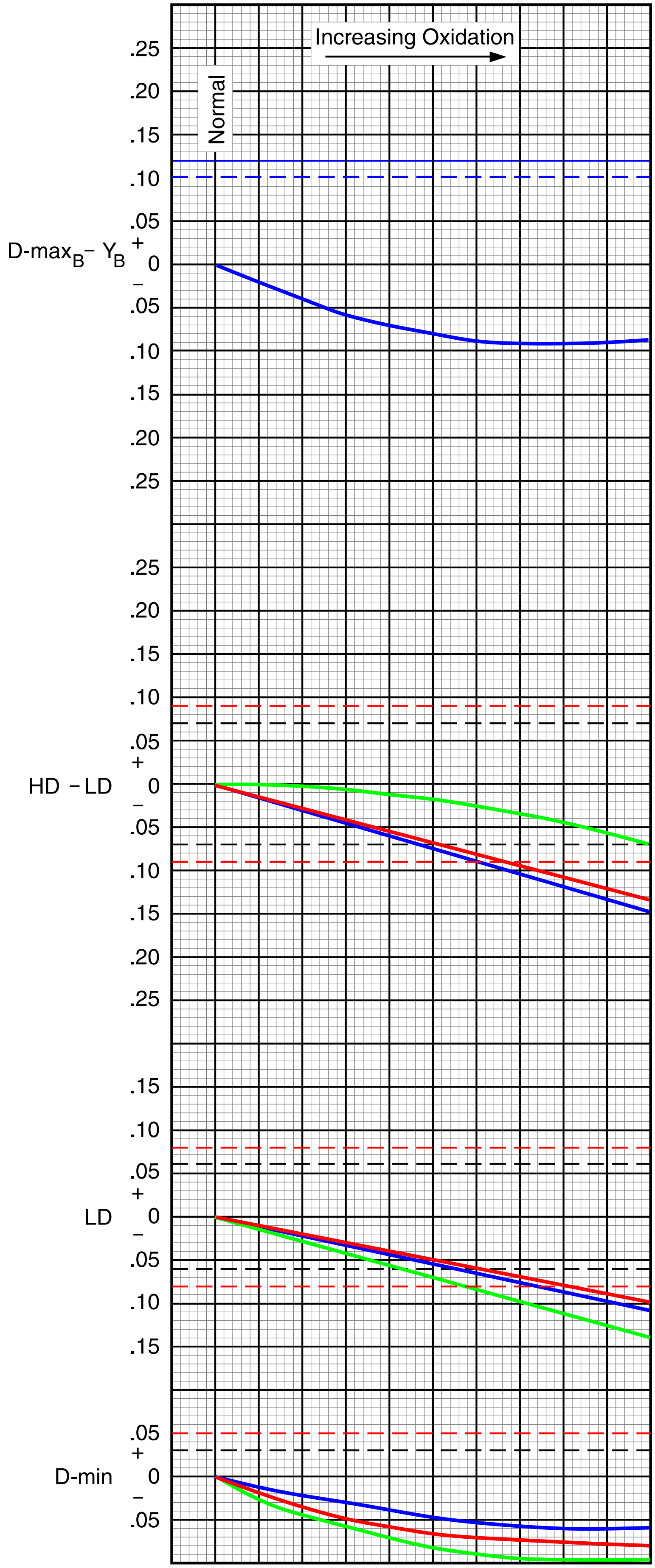
Developer Oxidation

Developer activity varies inversely with oxidation. Increasing developer oxidation causes less dye to form, lowering density values.

Oxidation can occur during idle periods when the processor is up to temperature, but not processing film. You should be able to avoid severe oxidation problems in most processors by ensuring that at least one developer tank turnover occurs every 4 weeks. If you are operating at low utilization, follow the recommendations in KODAK Publication CIS-190, *Recommendations for the Use of KODAK SM Chemicals in Low-Utilization Operations.*

Leaks in a recirculation line or filter will allow air to bubble into the tank solution, causing oxidation. Check your equipment for leaks if oxidation occurs.

Chart 9



Process C-41SM

Developer Contaminated with Bleach

Very small amounts of bleach will contaminate the developer and affect developer activity. The D-min and LD densities will increase because more dye forms due to chemical "fogging." And, HD – LD plots will also increase with more contamination.

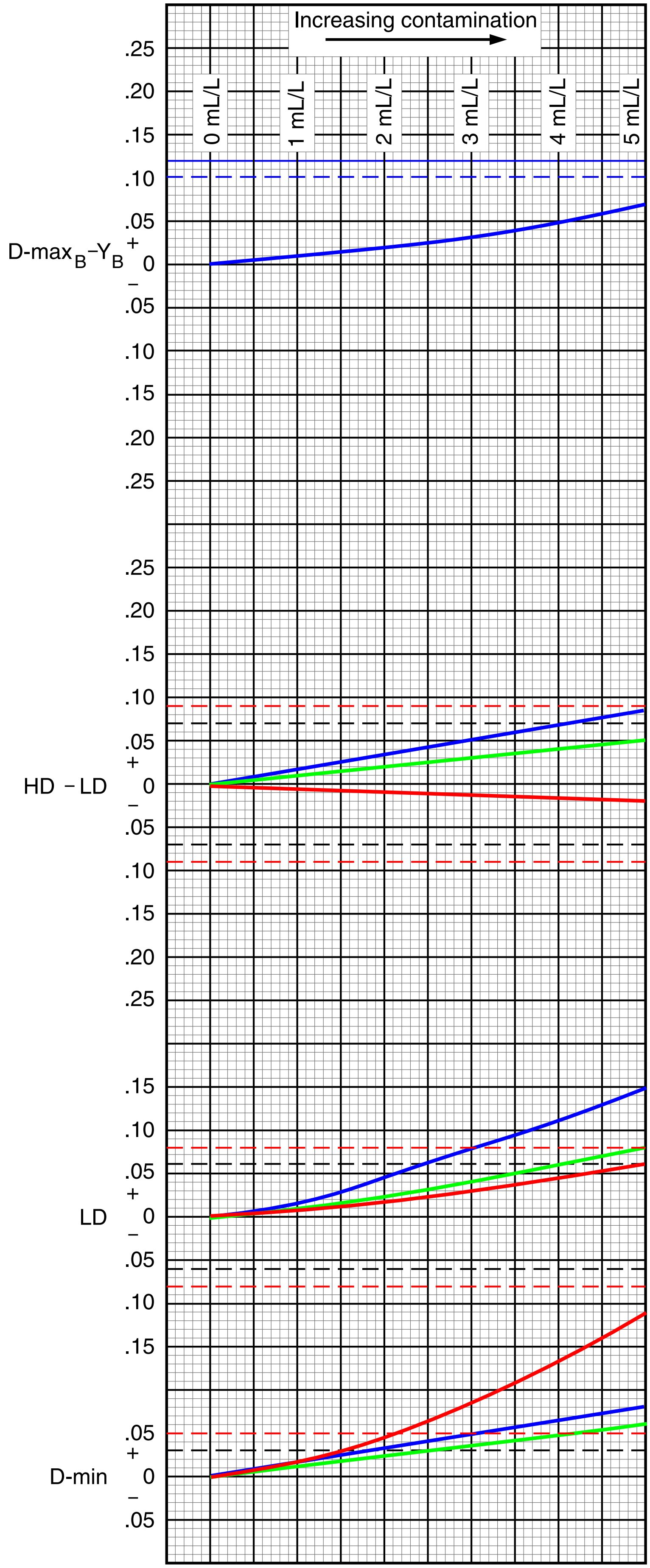
If bleach aeration is excessive, bleach solution can mist or splash and slowly contaminate the developer.

Bleach can splash back into the developer as the leader card and film emerge from the bleach. The developer can also be contaminated by less soluble bleach complexes that have been deposited on the leader card. Clean all leader cards thoroughly each day at shutdown; you may need to soak them in hot water to remove the bleach. Replace worn or damaged leader cards.

Make sure that bleach does not drip into the developer when you remove the bleach racks for cleaning, maintenance, etc.

If bleach contamination occurs, stop processing customer film. After you locate and eliminate the source of contamination, dump the developer tank solution, rinse the tank thoroughly, and mix a fresh developer tank solution.

Chart 10



Process C-41SM

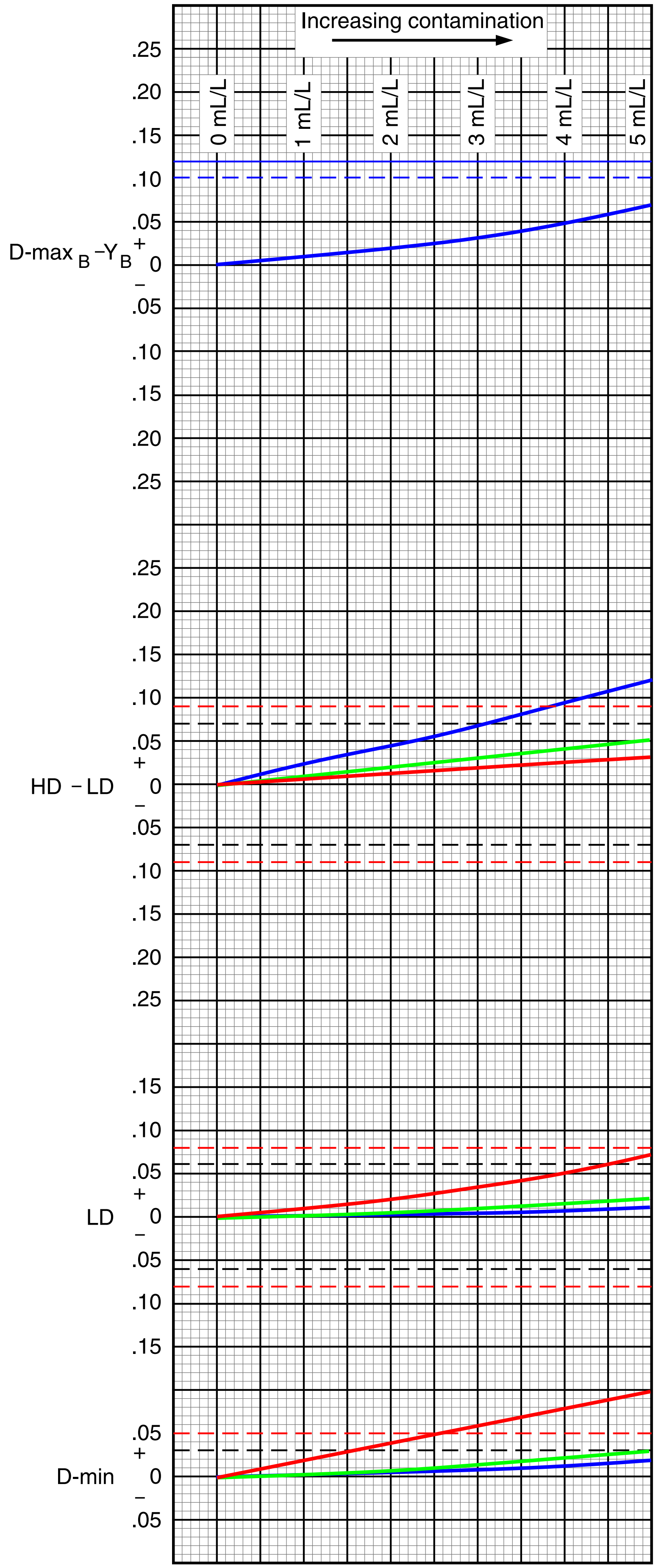
Developer Contaminated with Fixer

Very small amounts of fixer will contaminate the developer and cause chemical “fogging.” As contamination increases, dye density will increase in all of the control-chart plots. Fixer contamination is most noticeable as an increase in the red D-min density.

Fixer contamination of the developer usually occurs from leader cards that are not thoroughly clean. Clean all leader cards thoroughly each day at shutdown in hot water. Replace worn or damaged leader cards.

If fixer contamination occurs, stop processing customer film. After you locate and eliminate the source of contamination, dump the developer tank solution, rinse the tank thoroughly, and mix a fresh developer tank solution.

Chart 11



Process C-41SM

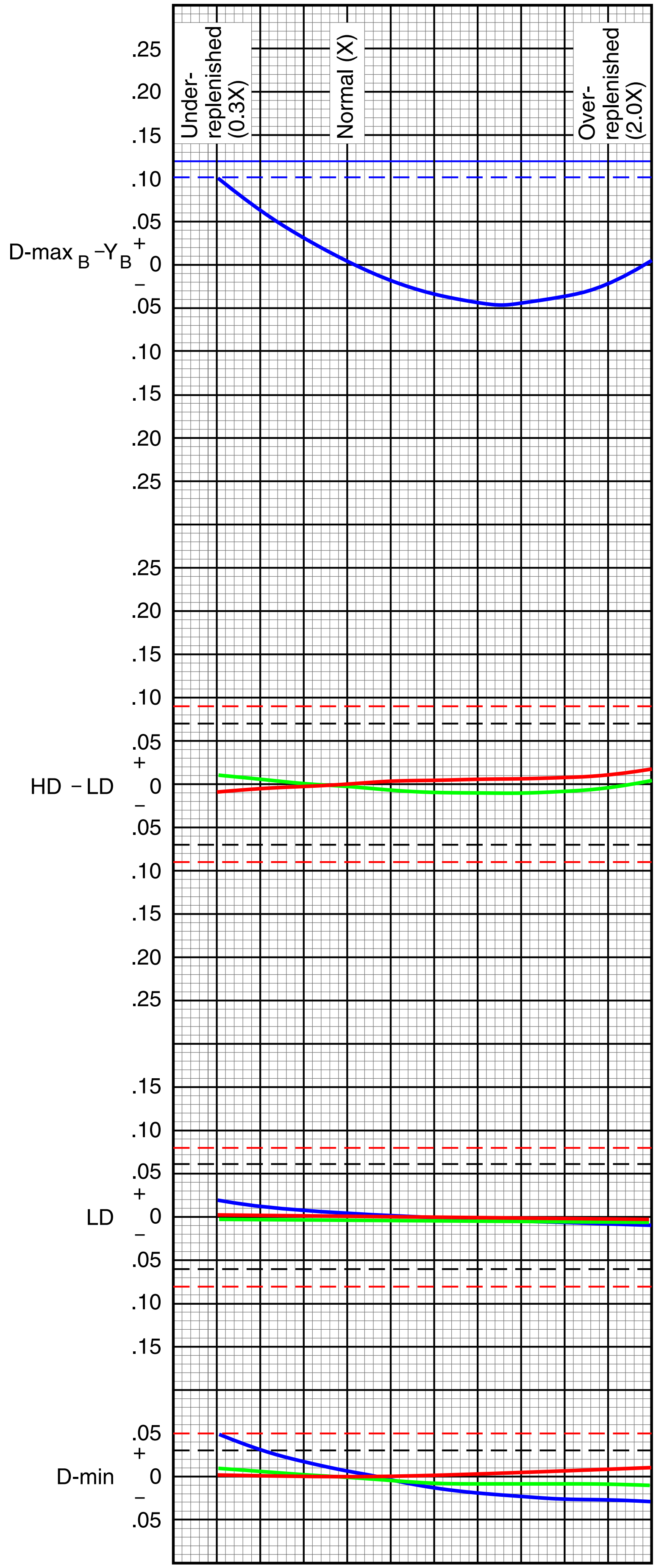
Bleach Replenishment Rate Too Low/High

Bleach activity is affected by improper replenishment. An underreplenished bleach solution will not adequately compensate for developer carryover. The pH of the bleach will increase and total iron will decrease causing retained silver.

An underreplenishment problem is most noticeable in the D-max$_B$ – Y$_B$ plot and the blue D-min density. If you think that the problem was caused by incorrect replenishment, check that the replenishment rate and setting are correct; adjust them, if necessary. Check the bleach replenishment rate regularly.

You can correct film that has been improperly bleached by rebleaching it in a known good bleach, and then completing the remaining processing steps. To test for retained silver, follow the procedure described in *Appendix A*. If retained silver is the problem, replace the bleach tank solution and recalibrate the bleach replenisher pump.

Chart 12



Process C-41SM

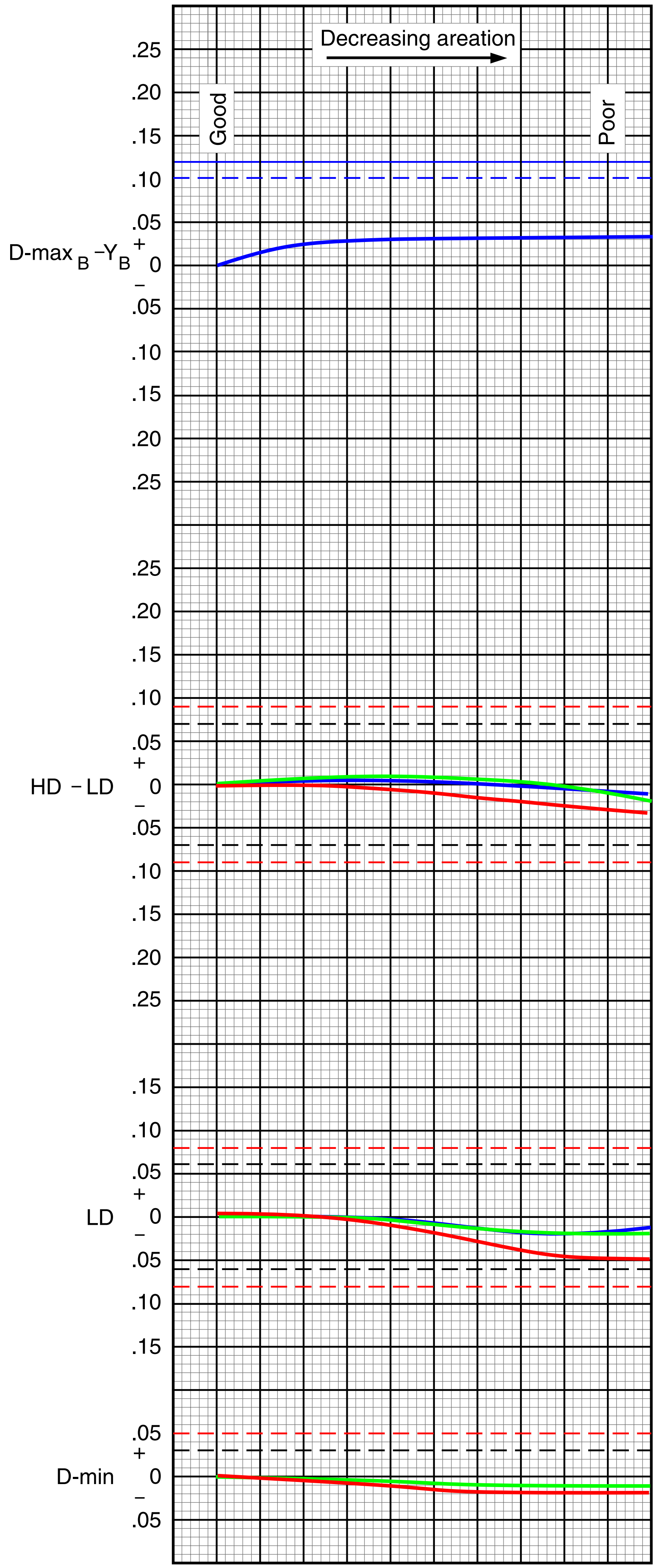
Bleach
Poor Aeration

Bleach activity depends on the amount of bleach aeration. Inadequate aeration causes retained silver and leuco-cyan dye.

If you determine that the problem was caused by inadequate aeration, check the air bubbling in the bleach tank. Be sure that the air supply is adequate, the tubing is clear, and the distributor tube is not clogged.

If you think that poor bleach aeration is causing an out-of-control condition, rebleach your control strip, and then complete the remaining processing steps. If rebleaching improves/increases the red HD – LD plot, the problem was caused by the bleach. You can correct film that has been improperly bleached by rebleaching it in a good bleach, and then completing the remaining processing steps. (See *Appendix A* for more information.)

Chart 13



Process C-41SM

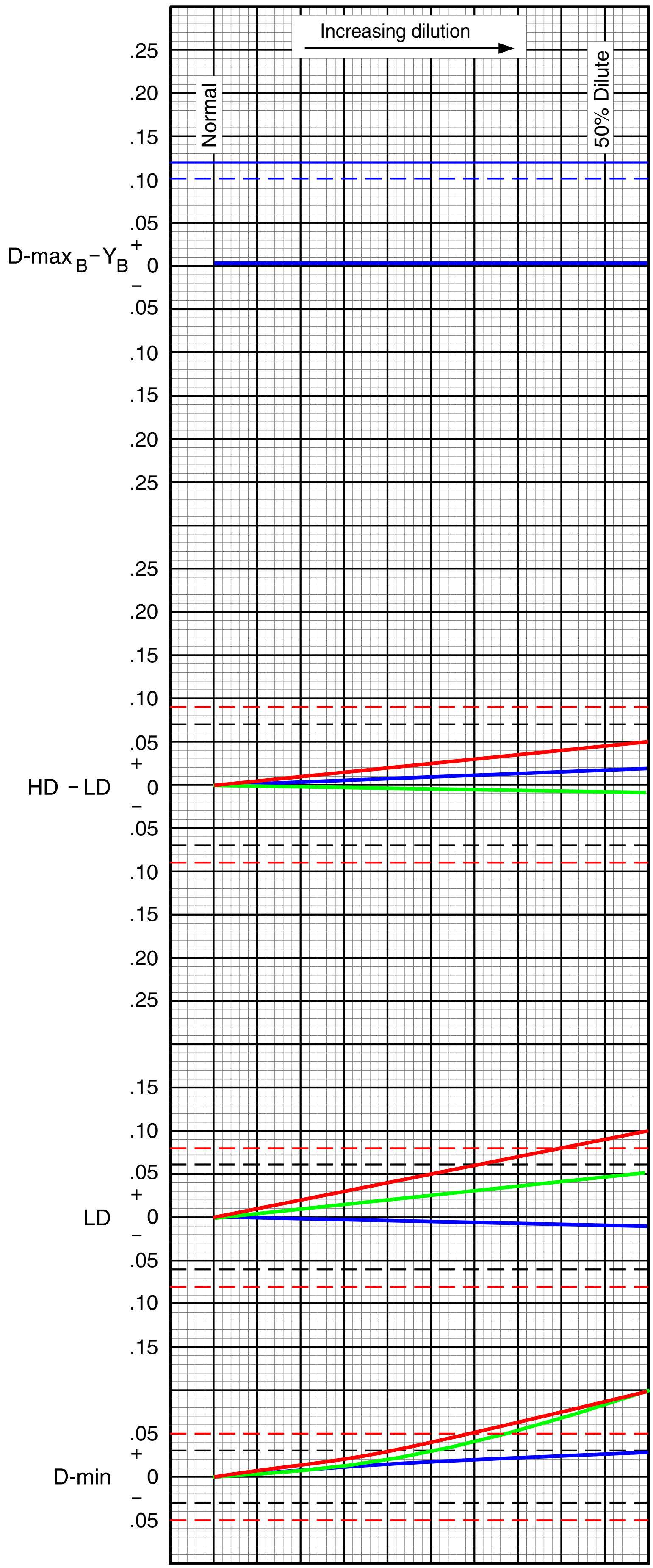
Fixer
Underreplenished or Too Dilute

Moderate levels of underreplenishment or fixer dilution can cause an increase in the red and green D-min and LD plot densities. When the fixer is extremely diluted, retained silver halide and sensitizer dye cause increased density in all control plots. When that occurs, the D-min areas of the film will appear cyan to a more opaque milky appearance.

The most probable causes of insufficient fixing are fixer dilution from excessive topping off with water or fixer underreplenishment.

If you think that diluted fixer is causing an out-of-control condition, refix and rewash your control strip according to the procedure in *Appendix B* on page 4-21. If refixing significantly improves the red and green D-min and LD densities, the problem was caused by the fixer. You can correct film that has been incompletely fixed by refixing and rewashing it. Be sure to eliminate the problem that causes dilution, or adjust replenishment as necessary.

Chart 14



Process RA-2SM

Developer
Temperature Too Low/High

The recommended developer temperature for Process RA-2SM is 40 ± 0.3°C (104 ± 0.5°F). A developer temperature that is too low or too high affects development and the amount of dye formed. If the developer temperature is too high, the density values for LD, HD – LD, BP, and perhaps D-min will plot higher than normal. If the developer temperature is too low, the density values for LD, HD – LD, and BP will plot lower than normal.

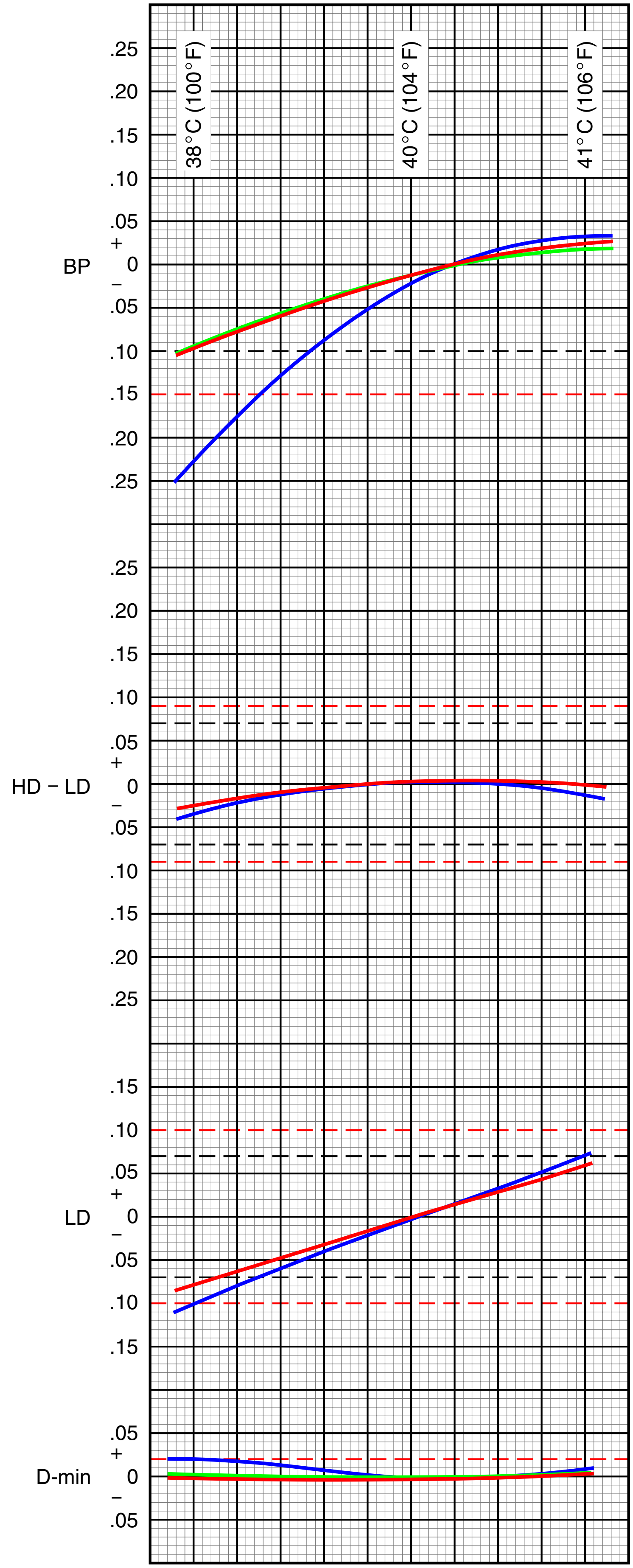
If you suspect that the developer temperature is incorrect:

- Check that the temperature regulator is operating.
- Check that enough time was allowed for the developer to reach operating temperature before processing.
- Check that the developer recirculation filter is not clogged. (A clogged filter can prevent proper heating of the solution.)

Check the temperature controller or the recirculation system; one or both can cause the problem. Replace the recirculation filters if they are clogged.

Check the developer temperature frequently, and adjust it as necessary.

Chart 15



Process RA-2SM

Developer
Replenishment Rate Error / Water Too Low/High

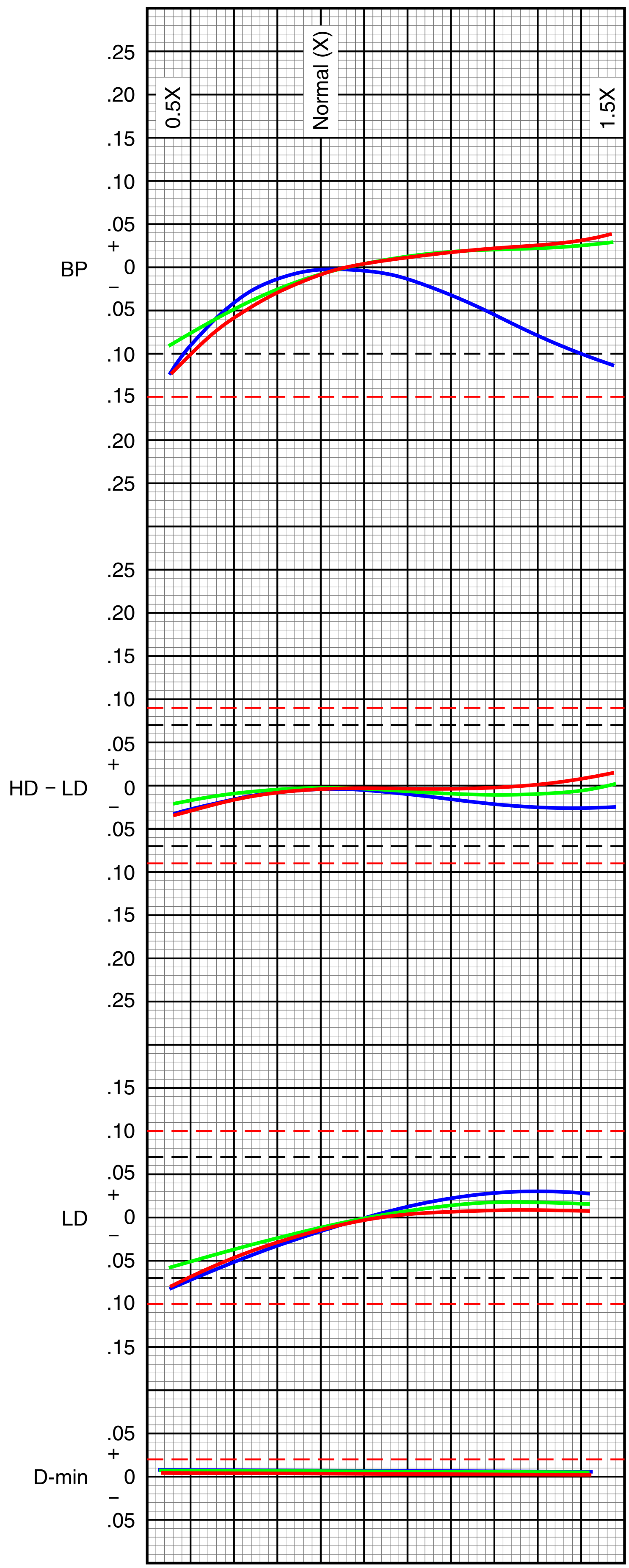
Developer activity varies with the delivery of water to your developer tank. Underreplenishment results in low activity in all three colors of BP; overreplenishment results in low activity of the blue BP.

How quickly your control plots change depends on the variation from aim of your replenishment delivery and the amount of paper processed.

If the water delivery is suspect:

- Check the developer replenishment pump fitting for water to be sure it is snug.
- Check the delivery lines for air. This is an indication that the pump valves have failed.
- Check the pump calibration.
- Check the replenishment rate setting.
- Update the pump values in your processor software.

Chart 16



Process RA-2SM

Developer Replenishment Rates Too Low/High

Developer replenishment rates (A:B:C:water) directly affect developer activity. If the rates are too high, the density values for LD and BP will plot higher than normal. If the rates are too low, LD, BP, and HD – LD will plot lower than normal. The amount of change that you see in the plot as a result of incorrect replenishment depends on the developer-tank volume, processor speed, and amount of paper processed. If incorrect replenishment appears to be the problem, check that the replenishment system is operating properly and is correctly calibrated.

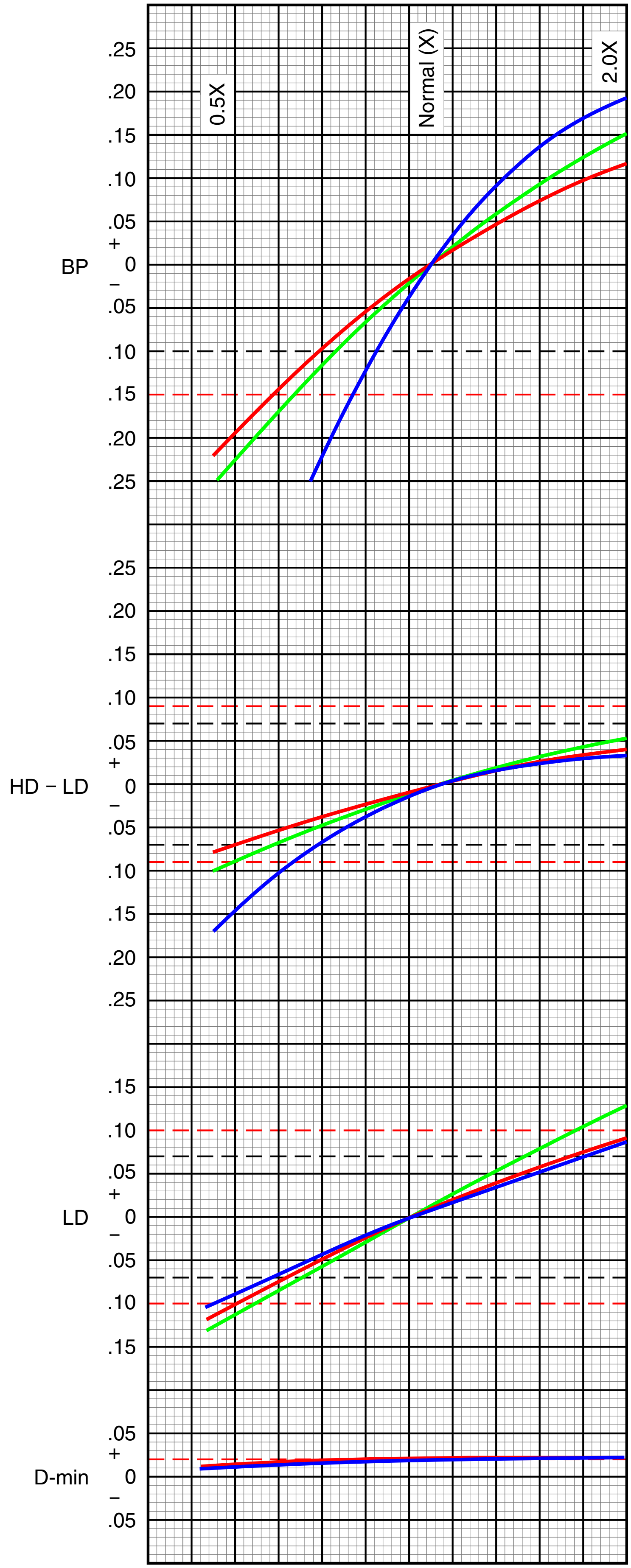
The recommended replenishment rates are *starting points only*. Exact rates depend on the type of paper you process, and how well you maintain operating conditions, such as development time and temperature. Determine your exact rates by monitoring the process with control strips and adjusting the rate as needed according to the control plot. However, do not adjust the rates to "chase" small changes in the control plot. Once your process is in control, continue to use the rates that you established; don't change them unless processor utilization changes. **Changing rates should be done proportionately with all developer parts, including water**.

To avoid replenishment problems, check the replenisher settings regularly to be sure that the correct rates and proper tank volumes are maintained.

If you suspect that replenishment is the problem:

- Check that the replenishment system is set correctly.
- Verify that the replenishment pumps are all operating.
- Verify that the replenishment pumps are producing the correct output.
- If the processor has been idle, verify that the "J" tubes are full of solution.

Chart 17



Process RA-2SM

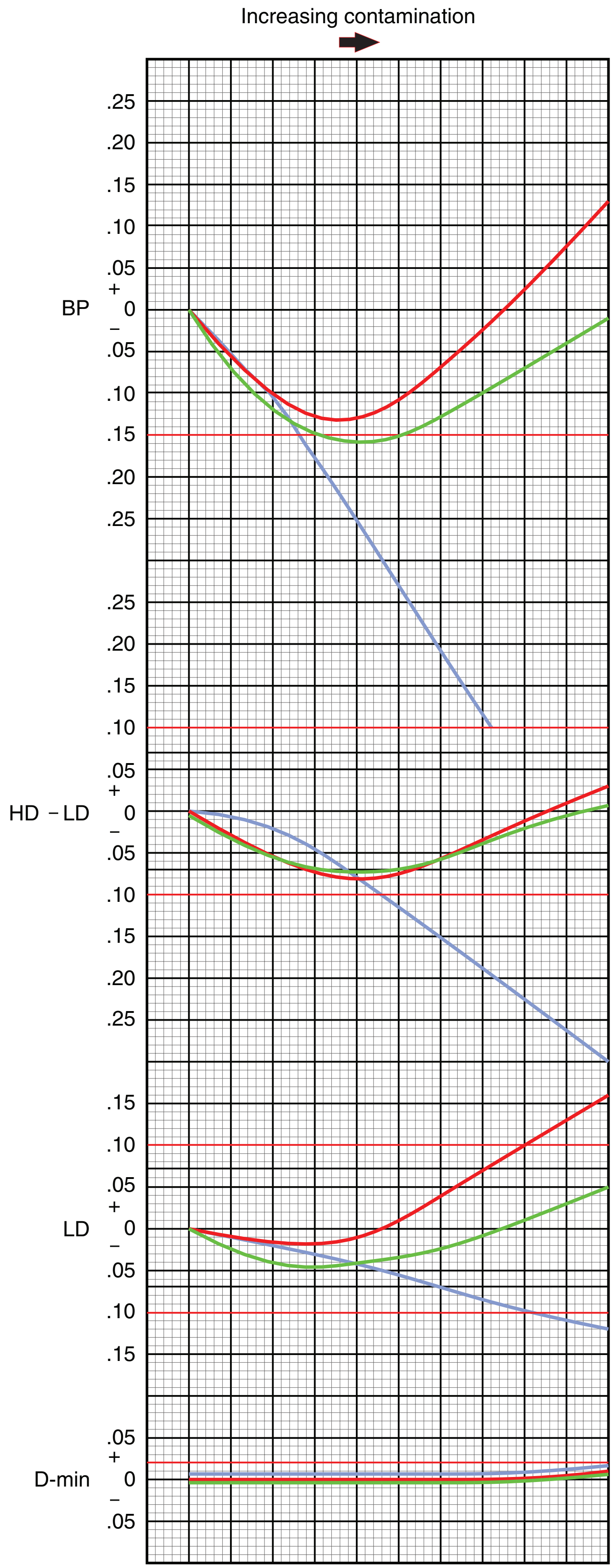
Developer Contaminated with Bleach-Fix

A very small amount of bleach-fix will contaminate the developer. As little as 0.1 mL/L of bleach-fix in the developer can cause an out-of-control process. If the developer is contaminated with bleach-fix, you will see a severe color change in the prints and large shifts in the control plots.

Possible sources of contamination are bleach-fix splashed into the developer when racks are raised or when developer is mixed with equipment that contains a small amount of bleach-fix from the last time it was used. Use a separate mixing bottle to mix developer working-tank solution, and wash it thoroughly. **Don't** mix a bleach-fix working-tank solution in a developer mixing bottle.

Stop production until you find the source of contamination. Check for any procedures that might cause splashing during processing. A developer contaminated with bleach-fix cannot be salvaged; replace it with a fresh mix.

Chart 18



F002_1283EC

Process RA-2SM

Developer Oxidation

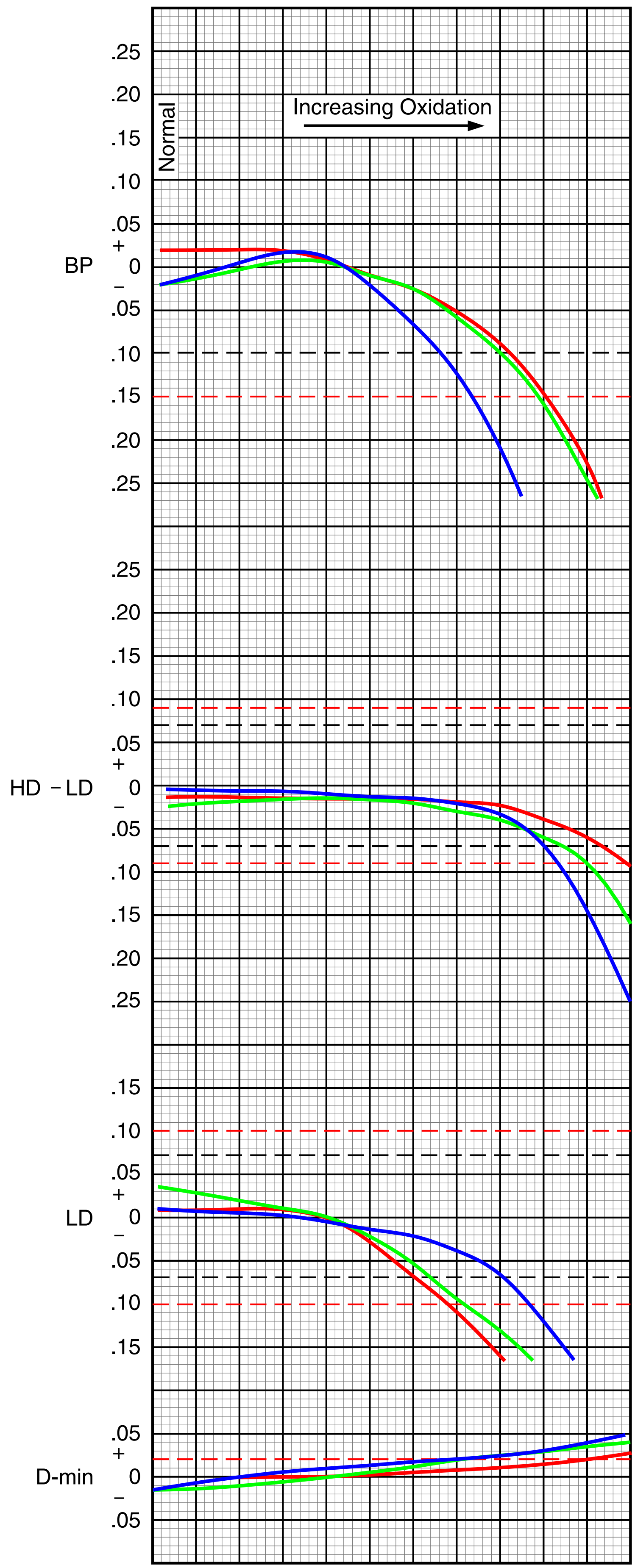
Developer, exposed to air, reacts with oxygen. To protect the developing agent, developers contain preservatives that react with oxygen. However, prolonged exposure to air will eventually deplete the preservative and cause the developing agents to oxidize. Oxidation of the developing agent causes decreased developer activity and the formation of a precipitate. You will see an increase in D-min, HD – LD, and a decrease in LD and BP in the control plots.

The most common causes of oxidation are excessive agitation or low processor utilization. Excessive agitation forces air into the solution, depleting the preservative more rapidly. This can occur when you mix a fresh working-tank solution by mixing it excessively or too vigorously, or it can occur inside the processor tank. A faulty processor recirculation pump can also cause oxidation by sucking air into the solution. Foaming may indicate that the recirculation pump is leaky and is pumping air.

Oxidation is a more common problem in roller-transport processors than in other types of processors because the rollers constantly expose large areas of solution to the air. Oxidation is also more likely in roller-transport processors because they often have low utilization, which means that the solution is exposed to air for long periods without replenishment. Without replenishment, preservatives in the developer are not replaced as they would be with normal utilization. Evaporation is also higher in low-utilization processors, leading to developer overconcentration. Overconcentration can offset some of the effects of oxidation and mask the condition.

Minimize oxidation by turning the processor off when it is not in use. Check for excessive air flow over the processor developer working tank, and reduce or minimize it.

Chart 19



Appendix A

Rebleaching Test for Determining Retained Silver, Process C-41SM

Use the following procedure to verify retained-silver problems.

1. Zero your densitometer. Measure and record the blue densities of the D-max and yellow steps of your control strip.
2. Rebleach the control strip for 5 minutes in a *known good bleach* (i.e., a properly constituted Process C-41 bleach).
3. Refix the control strip for 5 minutes in a *known good fixer* (i.e., a properly constituted Process C-41 fixer).
4. Wash the control strip for several minutes, and allow it to dry.
5. Rezero your densitometer. Read the blue densities of the D-max and yellow steps of the rebleached and refixed control strip.
6. Calculate the **change** in density readings of the control strip by subtracting the readings from step 1 from the readings from step 5. We will refer to these numbers as Δ D-max_B and Δ Y_B.
7. Subtract Δ D-max_B from Δ Y_B to determine the amount of retained silver. If the difference is greater than +0.08, a retained-silver problem exists. If the difference is less than +0.08, retained silver is most likely not the problem.

Note: You can remove retained silver from processed film by following the steps given below.

8. Rebleach the film in a *known good bleach*.
9. Refix the film in a *known good fixer*.
10. Wash, restabilize, and dry the film.

You can also use an infrared scope to detect retained silver.

Appendix B

Testing for Retained Silver Halide, Process C-41SM

Use this test to determine if processed film has retained silver halide.

1. Zero your densitometer. Read and record the red Status M density of the D-min step of a control strip that you have recently processed.
2. Refix the control strip for 5 minutes in a *known good fixer* or a solution made from KODAK Farmer's Reducer, Part B.
3. Wash the control strip for 2 to 3 minutes, and allow it to dry.
4. Rezero your densitometer. Read and record the red density of the D-min step of the refixed control strip.
5. Calculate the **change** in density readings by subtracting the reading from step 4 from the reading from step 1.

Any significant change in density readings after refixing indicates a fixer problem. If a *loss* in red density is greater than 0.05 for D-min or LD, a retained silver-halide problem probably exists due to low activity of the fixer tank solution. This problem may be accompanied by retained sensitizing dye. If the *loss* in red density is less than 0.04, the activity of the fixer tank solution is probably acceptable.