

PROCESS MONITORING

Z-129E
\$45.00

KODAK EKTACHROME R-3 and R-3000 Chemicals

MONITORING AND TROUBLESHOOTING PROCESSES USING KODAK EKTACHROME R-3 AND R-3000 CHEMICALS

To maintain a process that consistently produces good quality prints with the least amount of waste, match your process to a standard for density, color, and contrast each time you process KODAK EKTACHROME RADIANCE Papers or Materials. To ensure that your process gives you consistent high quality, regularly monitor it by processing reliable control strips that you can read with a densitometer. Use KODAK RADIANCE III Control Strips, Process R-3, to monitor your process.

NOTE: The information in this section represents process control situations as monitored with KODAK RADIANCE III Control Strips. Be sure you are using RADIANCE III Control Strips when comparing your process with these examples.

KODAK RADIANCE III CONTROL STRIPS, PROCESS R-3, ARE THE BASIC CONTROL MATERIAL

KODAK RADIANCE III Control Strips are exposed under carefully controlled conditions. They contain twenty density steps for measuring sensitive portions of the paper/process combination. Supplied with each box of control strips is an identically exposed reference strip that was processed under carefully controlled conditions in a standard process. By processing the control strips and plotting their density values, you can check whether your process matches the standard and is repeatable from one run to the next.

KODAK RADIANCE III Control Strips, Process R 3 (CAT 508 2953)

KODAK RADIANCE III Control Strips, Process R-3, are supplied in boxes containing five moisture-resistant envelopes of five strips each. A code number identifies each box of strips as part of a particular batch. This code number is also printed on each control strip and reference strip. Each box of strips contains correction factors for the specific code number. You will need to use these correction factors to obtain your aim values.

The strips measure 8.9 x 35.6 cm (3 1/2 x 14 inches) and have twenty density steps. To monitor Process R-3 or R-3000, read and plot the D-min, WD, LD, and D-max steps. Also read the HD step. Subtract LD from HD (HD-LD) and plot this value.

SOME TERMS RELATING TO CONTROL STRIPS AND PROCESS MONITORING

It helps to know the terms associated with control strips and control plots. Some of the most commonly used terms are used frequently in the description of process monitoring in this publication.

Control Strips—Exposed strips that you can use to check your process. They provide a standard against which you can monitor your process.

Code Number—The number that identifies a particular batch of control strips of the same emulsion and conditions of manufacture. The code number is printed on the reference strip, each control strip, and the box.

Reference Strip—A specially exposed and processed strip of the same code number as the strips with which it is packaged. Use it to obtain reading from which you calculate the aim values for your batch (code number) of control strips.

Correction Factors—Factors for each code given in the instruction sheet supplied with each box of control strips. Apply these correction factors to the reference-strip densities to obtain your aim values.

Aim Values—The standard to which you compare your control-strip readings. The aim values are obtained by adjusting the reference-strip densities with the correction factors.

Control Plot—A plot of the differences between the density values of the control strip and the aim values. Continuous plots allow you to monitor the consistency of your process, and to identify and correct any unacceptable shifts or trends.

D-max—Generally the highest density area of the control strip or print. D-max control values measure the effect of the process on color saturation in the areas of higher density and provide useful information about the condition of the color-developer solution. The effect of light fog on the paper is usually most easily seen in the D-max area.

LD—Low-density values. The LD density values measure the speed and color balance of the process. A high density in the LD area indicates a process that has a lower speed than a standard process; low density indicates a process with a higher speed than a standard process.

HD—High density values. These values are not plotted, but are used to plot the difference between HD and LD.

HD-LD—Subtracting the LD densities from the HD densities gives the contrast characteristics of the process.

WD—This is a measure of the quality of the highlights or whites in a print. The WD measurements are particularly useful to diagnose low activity of the first developer. For more information, see the section, “First Developer” on page 8.

D-min—A measure of minimum-density areas of the print. If density values plot higher than .03 above the aim, the process will produce prints with an unsatisfactory amount of stain. Values that plot lower than the aim are generally not a problem.

Tolerances and Limits—For information on the use of adjustment tolerances, see step 6 on page 7. Remember that correction factors are different for each code-number batch of control strips.

The tolerances and limits listed below apply to the control strips used to monitor processes using KODAK EKTACHROME R-3 Chemicals.

Tolerances and Limits—KODAK RADIANCE III Control Strips, Process R-3

Measurement	Aim-Value Adjustment Tolerance	Action Limits	Control Limits
D-min	—	—	+0.03
WD	—	—	+0.03
LD(R,B)	±0.08	±0.08	±0.12
LD(G)	±0.04	±0.04	±0.06
HD-LD	±0.04	±0.08	±0.12
D-max	±0.08	−0.08	−0.12

Action Limits—“Early-warning” limits. Action limits alert you to correct a condition that may cause your process to drift out of control. When any point exceeds the action limit, it is all right to continue production, but you should check for the cause of the shift and correct it before the process drifts out of control. The action limits also define an operating range for the process. It is not necessary to keep the process at the aim line for all density values as long as it remains within the “aim zone” (between the upper and lower action limits).

Control Limits—The largest shift in the control-strip density values that you can tolerate without a potentially adverse effect on production. When any point exceeds the control limit, stop production until you find the cause of the shift and correct it.

HOW SHOULD I STORE AND HANDLE MY CONTROL STRIPS?

Store unused control strips at -18°C (0°F) or lower. To prepare for the day's processing, remove the box of control strips from the freezer. Allow the box to warm up for at least 30 minutes before opening it. Remove only the day's supply of strips. Reseal the package and return the box to the freezer as quickly as possible. The box should not be left out of the freezer for more than an hour per day. Store the day's supply in a lighttight container at room temperature. Discard any remaining strips at the end of the day.

Always handle the control strips by their edges to prevent fingerprints and surface damage. If sticking, static marking, or mottle caused by condensation occurs, allow additional warm-up time before you open the package.

When you first remove the reference strip from the box, allow approximately 30 minutes warm-up before you read it on the densitometer. Reading it before it has warmed up sufficiently may give you erroneous data. Make sure you keep the reference strip in its envelope to protect it from light when you are not using it.

WHEN SHOULD I PROCESS A CONTROL STRIP?

Process a control strip at the beginning of the day before processing any customer paper or material. It is also good practice to process a control strip at regular intervals during production and at shutdown of the processor. Process the control strip with the D-min end up in rack-and-tank and sink-line processes. In continuous processing machines, splice the control strip so that the

D-min end enters the processor first. With the emulsion up, the notch in the upper right corner identifies the D-min end.

HOW DO I PLOT THE CONTROL STRIP DENSITY READINGS?

Make a chart by using the KODAK Process Record Form (Y-55), or similar graph paper. First draw in the tolerance limits, as shown in the example on page 6. These limits are explained on page 3. Use black for the action limits, and red for the control limits, as shown in the example. This chart becomes a running record of your process. It enables you to tell, at a glance, the condition of your process and any changes in it. Next, calculate your aim values by following steps 1 and 2 below. Fill in these aim values in the spaces on the left margin of the Y-55 form, along with the processor identification and control-strip code number. To plot the WD, you will need to modify your Y-55 form (example on page 6), or use a second form.

To read the strip, use a precision electronic densitometer, equipped with heat-absorbing glass and status A filters. If you don't need to compare your results with those from another densitometer, you can use KODAK WRATTEN Filters No. 92 (red), No. 93 (green), and No. 94 (blue). For the most precise measurement, be sure that you do not move the strip when making the density readings. Here is a step-by-step procedure for starting your process control plot:

1. Set up aim values by using the reference strip supplied with your current box of control strips. Allow the reference strip to warm to room temperature for about 15 minutes before you remove it from the envelope to read it. If you remove and read the strip while it is cold, you may get false readings; this will give you an incorrect control plot. Measure the red, green, and blue densities in the center of the D-max step, the high-density step (HD), the low-density step (LD), the white-density step (WD), and the D-min step.

If you have several boxes of strips with the same code number, read the control steps on the reference strips from six to eight boxes and average the readings.

The correction factors will be the same for a particular code number. Each batch is identified by a code number on the label of the control strip box and on the reference and control strips.

2. Apply the correction factors from the instruction sheet packaged with each box of control strips to calculate the aim values for each density plot. These corrected density values are the aim values for your process for that batch of control strips.

The corrected readings of the D-max step are the D-max aim values. The corrected readings of the HD step are the HD aim values. The corrected readings of the LD step are the LD aim values. Subtract the LD aim values from the HD aim values to obtain the aim values for HD-LD. The corrected readings of the WD step are the WD values. The average red, green, and blue readings of the D-min step become the D-min aim values. There are no correction factors for D-min.

Example of Determining Aim Values

		Red	Green	Blue
D-max	Average Reference-Strip Reading	2.56	2.53	2.47
	Correction Factor	+0.02	+0.01	-0.01
	Aim Value	2.58	2.54	2.46
HD	Average Reference-Strip Reading	1.85	1.70	1.73
	Correction Factor	-0.03	+0.02	+0.04
	Aim Value	1.82	1.72	1.77
LD	Average Reference-Strip Reading	0.65	0.64	0.60
	Correction Factor	-0.02	+0.01	+0.03
	Aim Value	0.63	0.65	0.63
HD-LD	HD Aim Values	1.82	1.72	1.77
	LD Aim Values	0.63	0.65	0.63
	HD-LD Aim Values	1.19	1.07	1.14
WD	Average Reference-Strip Reading	0.12	0.13	0.14
	Correction Factor	0.00	-0.01	-0.01
	Aim Value	0.12	0.12	0.13

- Process a control strip and measure the same steps that you measured in step 1.
- Calculate the difference between the aim values and the control-strip densitometer readings.
- Plot these differences on your control chart. Plot control-strip readings that are LARGER than the corresponding aim values ABOVE the base line, and those that are SMALLER than the aim values BELOW the line.
- If the action or control limits are exceeded, verify your densitometer calibration and readings, and check the control-strip code you are using against the reference-strip code. Then, if necessary, process another control strip for confirmation. If this confirms the plot, compare the pattern of your control chart to those in the section "Control-Chart Examples" to determine possible causes for the out-of-control condition.
- After you identify and correct the problem, be sure to process another control strip to verify that the process is in control again.

PROCESS R-3 (Control Strips and Reference Strips)

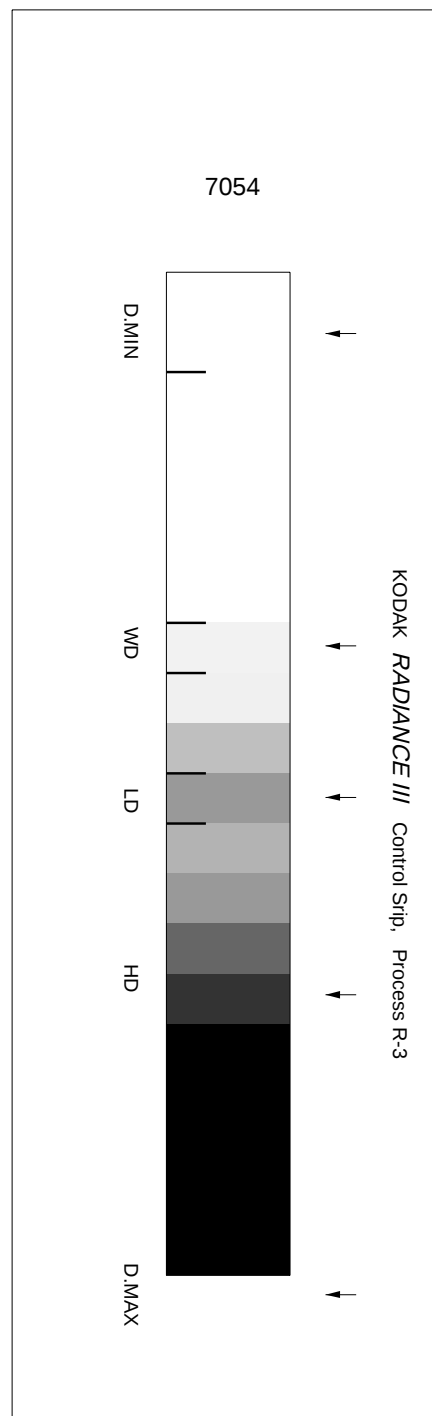
D-min ►

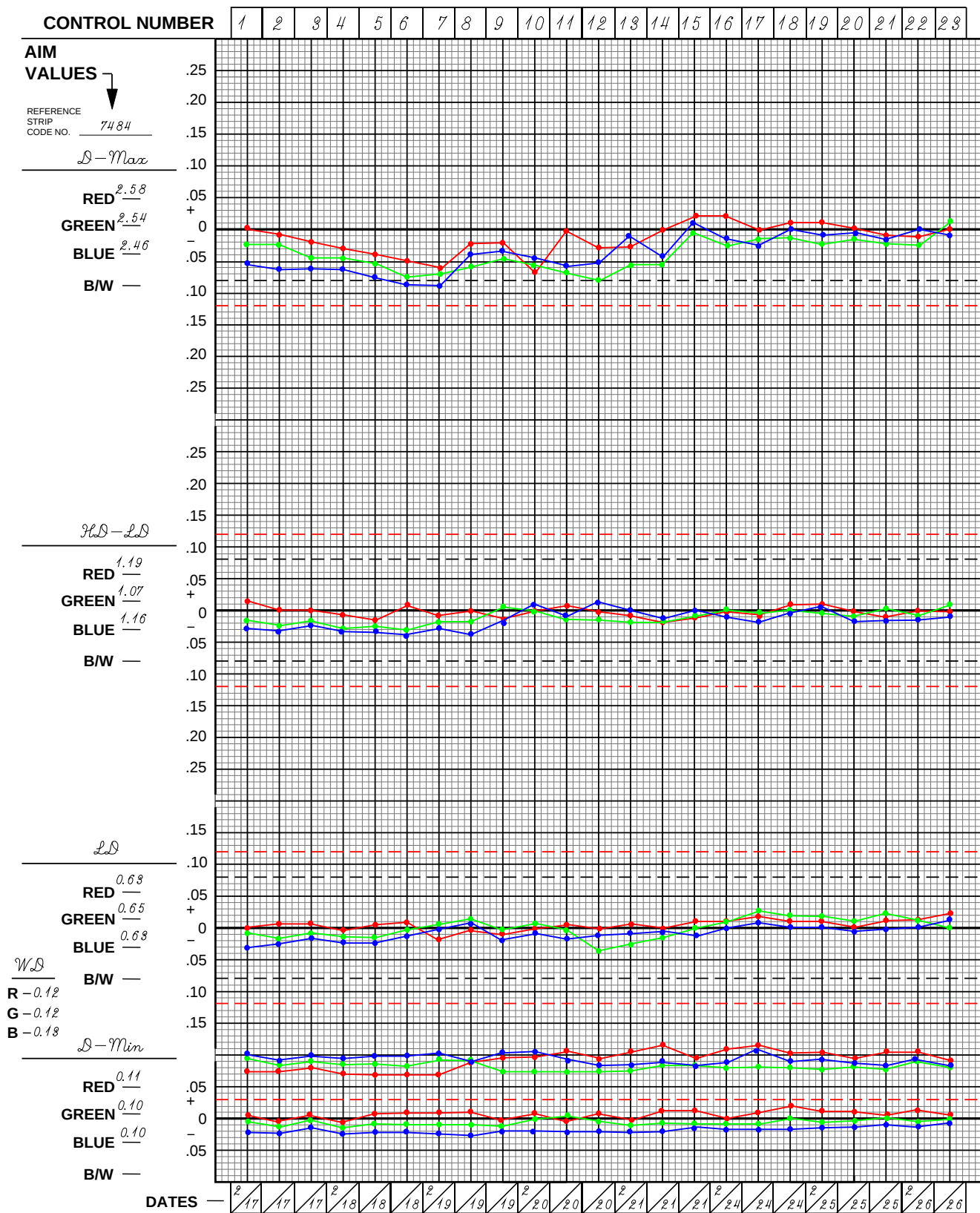
White density (WD) ►

Low density (LD) ►

High density (HD) ►

D-max ►





PROCESS R-8

MACHINE NO. 2

EASTMAN KODAK COMPANY, Rochester, N.Y. 14650

F009_0097EC

Record Form No. Y-55

Kodak is a trademark

Printed in U.S.A.



HOW DO I CHANGE TO A NEW BATCH OF CONTROL STRIPS?

When you change from your current batch of control strips to those with a different code number, you need to make a crossover to be sure that both code-number batches are giving the same information. To make a control-strip crossover:

1. On three separate occasions, process a control strip from the new code along with a strip of the current code. Do this while you still have a week's supply of control strips of the current code. Be sure your process is consistent and in control. If you are using the same batch of strips to monitor more than one processor, run a crossover on each machine.
2. Read the control-strip densities of the three current and three new control strips.

Example of LD Readings

Strip	Current Strips			New Strips		
	Red	Green	Blue	Red	Green	Blue
1	0.67	0.60	0.54	0.65	0.59	0.62
2	0.65	0.59	0.56	0.63	0.57	0.62
3	0.65	0.58	0.57	0.62	0.57	0.60

3. Determine the aim values for the new batch of control strips as described on page 4.
4. Plot readings of the three current strips against their aim values. Plot the readings of the new strips against the aim values that you determined in step 3.
5. Determine the differences between the plotted values of the two sets of strips. Calculate the average of these differences; then divide the result by 2.
6. Use the values obtained in step 5 to adjust the new aim values. The amount of adjustment should be small; at no time should it be greater than the aim-value adjustment tolerances shown on page 3. If the adjustment is greater, look for the cause. Check your calculations, your densitometer, and your control strips.
7. Plot the new control-strip readings against the new adjusted aim values.

MAKING THE CROSSOVER MATHEMATICALLY

You can also cross over to a new control-strip code number by using a simple mathematical method. With this method, you don't need to plot the readings of the two sets of control strips. Just follow the procedure shown in the chart below. You can make your own worksheets by making copies of this chart.

Calculation	Example	Red	Green	Blue
1. Current reference	0.67			
2. Plus new reference	+0.65			
3. Equals	1.32			
4. Multiply by 3	x3	x3	x3	x3
5. Equals	3.96			
6. Add the readings of the three new strips to total in step 5	+0.65			
	+0.63			
	+0.62			
7. Total of 5 and 6	5.86			
8. Subtract the readings of the three current strips	-0.67			
	-0.65			
	-0.65			
9. 7 minus 8	3.89			
10. Divide by 6	÷6	÷6	÷6	÷6
11. Equals	0.648			
12. New adjusted reference (rounded)	0.65			

WHAT SHOULD I DO WHEN A CONTROL STRIP PLOTS BEYOND THE CONTROL LIMITS?

Your control plot provides you with an ongoing record of your process. It will show how consistent your process is and how well it matches the aim. It provides you with helpful information for analyzing and correcting process problems. Your process will consistently produce quality results if the control strips always plot within the aim limits.

When a control strip plots outside the control limits or if the plot shows a gradual drift toward an out-of-control condition, immediately check for the cause and correct it. For information on analyzing process problems, see “Troubleshooting Your Process” on page 14.

HOW DOES EACH PROCESSING STEP AFFECT MY RESULTS?

Each solution affects the paper in a different way. It's helpful to understand how each solution reacts with the emulsion. This understanding, along with the control-chart examples and the diagnostic charts in this publication, will help you analyze process problems.

FIRST DEVELOPER

KODAK EKTACHROME RADIANCE Papers and Materials have three emulsion layers with a different coupler incorporated into each layer. A negative latent image is produced in each of the three emulsion layers of the paper by exposure to light.

In the first developer, the exposed silver halide grains (latent image) in each emulsion layer are converted into metallic silver (negative silver image).



This chemical reaction forms a negative black-and-white silver image in each of the three sensitized layers. No dye is formed at this stage of the process. The first-developer stage is the most sensitive step in the process. The activity of the developer depends on temperature, time, replenishment rate, and replenisher concentration. Time, temperature, and agitation determine the diffusion rate of chemicals into and out of the emulsion layers.

Increased first-developer activity results in too little dye formed later in the process; decreased activity results in too much dye formed. Formation of the three dyes is usually not affected equally by a first-developer variation because each dye layer has its own sensitivity to first-developer variations. However, an increase in first-developer activity usually results in a decrease in the formation of all three dyes. A good measure of low first-developer activity is the WD measurement. If the LD values are high, check the WD values.

Deviations from the recommended developing time, temperature, agitation, and replenishment rate of the first developer will affect speed (density), color balance, contrast, D-max, and WD.

A common mistake is to adjust the first-developer temperature to correct for low D-max. Once you set the speed of the process by obtaining green LD values that are within ± 0.04 of the aim values (see KODAK Publication No. Z-129B, Using KODAK EKTACHROME R-3 Chemicals in Continuous and Roller-Transport Processors), do not change the first-developer temperature. If you ignore that rule, and adjust the first-developer temperature to correct for blue D-max, the toe of the curve will be cyan and the whites and highlights of the prints will appear “dirty.” You will also see WD value increase greater than 0.03. If the D-max is low, first check color-developer activity (color-developer temperature, replenishment rate, and the efficiency of the squeegee at the entrance of the color developer.)

FIRST WASH

This wash stops development and removes first developer so that it will not contaminate the color developer. Incorrect water flow rate or wash time affects speed (density), color balance, and contrast.

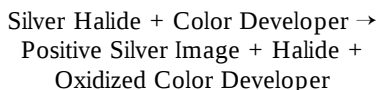
REEXPOSURE

In this step, the remaining unexposed silver halide grains in the emulsion layers are exposed to light and made developable. Inadequate reversal exposure results in a loss of overall D-max, a decrease in contrast, and a reduced print density.

COLOR DEVELOPER

The remaining undeveloped silver halide in each emulsion layer (exposed in the reexposure step) is reduced by the color developer to form positive silver and dye images in each layer.

The reaction for oxidizing the color developer is:



As the positive silver images are formed, the oxidized color developer combines with the three different dye-forming agents (couplers) already incorporated in the emulsion layers to form a positive dye image in each of the three layers. During color development, one coupler produces cyan dye, another produces magenta dye, and the third produces yellow dye.



SECOND WASH

This wash minimizes the amount of color developer carried over into the bleach-fix to maintain the correct activity of the bleach-fix solution.

BLEACH-FIX

When you use KODAK EKTACHROME R-3 Chemicals, bleaching and fixing take place in the bleach-fix. In a reversal process, all the silver halide is developed to silver (not just the negative silver image). Therefore, all the silver must be converted to ionic silver by the bleaching component before it is removed by the fixing component. The positive dye image is not affected.

The bleach-fix has two purposes. First, its oxidizing agents convert metallic silver into silver ions. Second, it acts as a fixer to react with the ionic silver and remove it from the emulsion. Oxygen taken into the bleach-fix during normal processing aerates the bleach-fix and reconverts the reduced bleaching agent to an active form.

The amount of metallic silver converted to silver ions depends on the bleach-fix concentration and the rate of bleach-fix diffusion through the emulsion. Bleach-fix concentration is affected by the replenishment rate, mixing procedures, and aeration efficiency. Bleach-fix agitation and temperature affect the rate of diffusion. (Using an abnormal bleach-fix can also affect the amount of cyan dye in your prints by causing some of the dye to change to a leuco or colorless form.)

Insufficient bleach-fixing can cause retained silver when some of the metallic silver is not converted to ionic silver. An increase in D-min is an indicator of insufficient bleach-fixing and retained silver. You can sometimes correct for retained silver by processing the paper again through a good bleach-fix solution.

Bleach-fix overflow and low-flow wash contain a considerable amount of silver in the form of silver thiosulfate. You can recover the silver profitably by using electrolytic silver recovery or a KODAK Chemical Recovery Cartridge, Model II. See KODAK Publication No. Z-129-G, *Recovering Silver from Processes Using KODAK EKTACHROME R-3 Chemicals*.

FINAL WASH

Washing removes the chemicals from the paper after processing. Good washing requires enough circulation to keep fresh water in contact with the emulsion. The water temperature must be warm enough to swell the gelatin so that the water moves freely into the emulsion.

Thorough washing is required for stability of the photographic image; chemicals remaining in the paper can degrade the image and cause dye fading. Follow washing instructions carefully. For more information on washing, see KODAK Publication No. Z-129B, *Using KODAK EKTACHROME R-3 Chemicals in Continuous and Roller-Transport Processors*; and No. Z-129C, *Using KODAK EKTACHROME R-3000 or R-3 Chemicals in Batch-Type Processors*.

FOR GOOD PROCESS CONTROL, CONTROL THE PROCESS VARIABLES

Process variables include process time, temperature, agitation, replenishment, and wash rates. Changing these variables affects the process in specific ways. Being aware of how each of these variables affects your process will help you troubleshoot problems and use these variables to make small adjustments in your process.

PROCESS TIMES

Time affects process control in about the same way that temperature does. It is particularly critical that you use the correct developer times. To determine the time for a solution, measure it from the time the paper or material enters the solution to the time it enters the next solution.

The recommended times for KODAK EKTACHROME R-3 Chemicals in continuous and roller-transport processors are:

Step	Recommended Process Time
	min:sec
First Developer	1:15 ± 5 sec
First Wash	1:30 ± 5 sec
Color Developer	2:15 ± 5 sec
Second Wash	0:45 ± 5 sec
Bleach-Fix	2:00 ± 5 sec
Final Wash	2:15 ± 5 sec

PROCESS TEMPERATURE

Slight variations in the developer temperatures, especially the first developer, can affect process control. Be sure that the thermometer you use is accurate to $\pm 0.15^{\circ}\text{C}$ ($\pm 0.25^{\circ}\text{F}$). In other solutions, temperature variations of a few degrees are not critical.

The recommended temperatures for KODAK EKTACHROME R-3 Chemicals in continuous and roller-transport processors are:

Step	Recommended Process Temperature	
	$^{\circ}\text{C}$	$^{\circ}\text{F}$
First Developer	38 ± 0.3	100.4 ± 0.5
First Wash	35 to 41	95 to 106
Color Developer	38 ± 1	100.4 ± 2
Second Wash	25 to 41	77 to 106
Bleach-Fix	38 ± 1	100.4 ± 2
Final Wash	25 to 41	77 to 106

If necessary, you can adjust the first-developer temperature within a range of 36 to 40°C (96.8 to 104°F) to achieve the recommended process speed (green LD). However, once you have established the first-developer temperature in the start-up procedure, make no further adjustment and maintain the temperature you have chosen to within $\pm 0.3^{\circ}\text{C}$ ($\pm 0.5^{\circ}\text{F}$).

AGITATION

Agitation increases solution activity by removing used solution from the surface of the paper or material and replacing it with fresh solution. Too little agitation causes streaks or spots on the paper or material. Too much agitation mixes air into the solution, causing some of the chemicals to oxidize. Oxidation is particularly harmful to the first and color developers.

In continuous processors the movement of the paper or material through the solution and solution turbulence provide agitation. In roller-transport processors, agitation is provided by the rollers.

REPLENISHMENT

During processing, some chemicals in the processing solution are used up, and some chemicals in the paper or material dissolve into the solution. These changes exhaust the solution. To compensate for these changes and restore normal solution activity, you can add a replenisher solution. The rate at which you add this replenisher affects the tank solution composition and activity.

Maintaining accurate replenishment is necessary for good photographic quality. Photographic stability depends on the ratio between the replenishment rate and the carry-in rate. Inefficient squeegees can cause sensitometric deviations, especially on leader-belt processors.

You can add replenisher in four ways:

Batch Replenishment—You add the replenisher in a single amount after processing a batch of paper or material. This is used primarily in sink-line processors.

Continuous Replenishment—Add replenisher at a set rate as the paper or material is being processed. This is the most commonly used method with large continuous processors.

In-Line Dilution—This is the same as continuous replenishment except that you meter in concentrate and water separately instead of using a mixed replenisher. This method is used with many small automatic processors.

Intermittent Feed—The replenisher is added after a specified amount of paper or material is processed. This requires sensors to measure the width of the product being processed.

With the last three methods, it is important that you calibrate and check the replenisher pumps and flowmeters regularly to be sure they are metering in correct amount of solution.

Use only the rates recommended, especially with the developers. Initially incorrect replenishment rates may not appear to affect your control plot, but eventually the effect will be significant.

On leader-belt processors, a higher color-developer replenishment rate is required to compensate for the excess water carried in by the belts (see footnotes of Table 2 in KODAK Publication No. Z-129B, Using KODAK EKTACHROME R-3 Chemicals in Continuous and Roller-Transport Processors).

KODAK EKTACHROME RADIANCE Overhead Material and RADIANCE Display Material require higher solution replenishment rates than other KODAK EKTACHROME RADIANCE Papers or RADIANCE SELECT Material. However, if the amount of overhead material processed is less than 10 percent of the total processing load, you can process it without increasing replenishment rates.

Wash-Water Control—Maintain the wash-water temperature and flow rate according to the recommended steps and conditions for your processor. Although RADIANCE Products are not too sensitive to these effects, a low flow rate or incorrect temperature in the first wash can cause D-max, speed and color-balance changes. In the final wash, these conditions will cause poor dye stability.

Replace water filters regularly to reduce dirt in the wash water. Use a flowmeter to regulate the water flow rate accurately. To minimize algae formation, drain the wash tanks each night, and especially over weekends and holidays. Use the same wash-water flow rates for processing EKTACHROME RADIANCE Papers and Materials.

Replenishment and Wash-Water Rates—

The recommended rates are:

RADIANCE Papers and SELECT Material

Step	Replenishment Rate	
	mL/m ²	mL/ft ²
First Developer	330	30.6
First Wash	5000	465.0
Color Developer	330*	30.6
Second Wash	1000	93.0
Bleach-Fix	220**	20.4
Final Wash	5000	465.0

* For leader-belt processors, use a color-developer replenishment rate of 500 mL/m² (465 mL/ft²).

**This replenishment rate applies to a two countercurrent tanks configuration. For a single tank configuration, the replenishment rate must be 500 mL/m² (465 mL/ft²).

NOTE: For replenishment rates for low-utilization processors, see the section “How Does Low Utilization of the Processor Affect My Process?,” in KODAK Publication No. Z-129B, Using KODAK EKTACHROME R-3 Chemicals in Continuous and Roller-Transport Processors.

RADIANCE Overhead and Display Materials

Step	Replenishment Rate	
	mL/m ²	mL/ft ²
First Developer	520	348.3
First Wash	5000	465.0
Color Developer	670	62.2
Second Wash	1000	93.0
Bleach-Fix	330**	30.6
Final Wash	5000	465.0

*This replenishment rate applies to a two countercurrent tanks configuration. For a single tank configuration, the replenishment rate must be 750 mL/m² (698 mL/ft²).

Recirculation—Recirculation keeps the temperature uniform throughout the processing solution. Use recirculation for all solutions.

Filtration—Processing solutions and wash waters may contain insoluble solids and tars. If you don't remove them, they can adhere to the paper or material and to tank walls, rollers, and lines, and damage prints. Filters should be able to remove 15- to 25-micron-size particles from processing solutions and wash water.

The following is a list of the filter materials that are satisfactory for use with KODAK EKTACHROME R-3 Chemicals:

- Bleached cotton
- Cellulose with phenolic resin binder
- Polyester fiber
- Polyester with phenolic resin binder
- Polypropylene
- Spun polypropylene
- Activated carbon

DO NOT use fiberglass with phenolic binder, wool with phenolic resin binder, viscose rayon, or viscose rayon with phenolic resin binder.

Polypropylene is the most acceptable filter-core material and one of the least expensive. Many polypropylene yarns are produced by using surfactants. While polypropylene appears to have no photographic effect, some surfactants may. Therefore, monitor your process carefully when you first change filters. Replace filters regularly as part of your routine maintenance schedule.

When you change filters, monitor the process carefully for color or speed shift. If you change vendors, test any unknown filter material for photographic effects before you use it.

Activated-Carbon Filtration—If your processor has low use, install an activated-carbon filter in the color developer recirculation line. It will prevent the buildup of oxidized chemicals that can cause pink stain. The following are some filters that you can use:

Filter

Polysales Filter
Model No. PS-232-9.8

Serfilco Filter
Model No. SFC-10W-carbofyne

Filter Micro-Carbon
Model No. C9.75PWS

Manufacturer or Distributor

Seneca Tek, Inc.
109 Despatch Drive
East Rochester, New York 14445

Serfilco, Inc.
Division of Service Filtration Corp.
1234 Depot Street
Glenview, Illinois 60025
or
Serfilco Europe
Ashburton Road
Trafford Park
Manchester, M17 1RW, England

Trumpler Clancy
34 E. Main Street
Hamburg, New York 14075

Drying—Do not use drying temperatures higher than 71°C (160° F). High drying temperatures cause excessive curl. Filter the drying air to reduce dirt. Do not ferrotype KODAK EKTACHROME RADIANCE Papers or Materials.

KEEP PROCESSING CHECKLISTS AND LOGS

Routine use of a start-up and shutdown checklist will help you keep your processor in good operating condition. Also use a checklist to follow a regular processor-maintenance schedule. An example of a start-up/shutdown checklist is shown on page 12.

Keep a daily processing log for your processor. It is a convenient way of keeping track of the amount of paper you process and can provide you with valuable information in case of processor problems. An example is shown on page 13.

PROCESSOR CHECKLIST

	Mon	Tues	Wed	Thurs	Fri	Sat	Comments
Date							
START-UP							
1. Turn on drive							
2. Turn on dryer fan							
3. Turn on water							
4. Open replenisher valves							
5. Open replenisher valves							
6. Open processor air vent							
7. Rinse top rollers with a squirt bottle							
8. Top off tank solutions							
9. Process clean-up sheets							
10. Check developer temperature							
11. Process control strip (let strip warm up for 10 minutes)							
12. Weekly—Change solution filters; drain and rinse wash tanks Monthly—Change water filters							
SHUTDOWN							
1. Process a control strip							
2. Turn off drive and dryer							
3. Enter amount of paper processed on signout sheet							
4. Shut off replenisher valves							
5. Shut off water valves							
6. Close processor air vent							
7. Daily—Rinse crossovers, top rollers, and gears of first-developer, color-developer, and bleach-fix tanks, with a squirt bottle							
8. Twice weekly—Remove crossovers and wash them with warm water.							
9. Weekly—Treat wash-water tank with 50 mL per Litre of household chlorine bleach. Let stand for 30 minutes. Then clean and flush the tanks with fresh water.							

DAILY PROCESSING LOG

Processor_____ **Operator**_____ **Date**_____

[illegible]

TROUBLESHOOTING YOUR PROCESS

You have lots of resources to help you solve processing problems. Your primary ones are your process-control plots, the diagnostic charts, the visual appearance of the prints, the control chart, examples of start-up and shutdown procedures in this manual, and maintenance records for your processor.

Start your analysis by verifying that all tasks on the processor Daily Checklist (see example on page 12) have been done; sometimes that check can identify a condition that caused the problem.

Next analyze your control plots. Are any density values beyond the action limits? If there are, immediately process another strip to verify the last strip. Are any density values beyond the control limits? If there are, STOP processing customer work until the problem is corrected and the process is in control again. If you have processed and plotted your control-strip results regularly, you will be able to determine whether it was a gradual or a sudden change.

Slow Drift or Sudden Change?

Did the process drift out of control slowly over a period of time, or did it occur suddenly? Sudden changes are those with a control-plot shift of more than eight density units. Gradual changes are those in which the plotted density values move in one direction—up or down, or over several processing days, until they finally drift beyond the process action limits. During either type of change, the red, green, and blue LD control plots usually shift in the same direction. However, the changes for each of the control values may not be equal.

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

Replenishment—This may be an incorrect replenishment rate or an incorrectly mixed replenisher. Another possibility is a defective replenisher pump.

Evaporation or Oxidation—This can be caused by low utilization or by too much air flow around the processing solutions.

Contamination—Although most contamination will cause a sudden out-of-control condition, contamination from the color developer by the belts of a leader-belt processor will occur gradually. A contaminated replenisher will also show a gradual change.

An out-of-control condition that occurs suddenly can be caused by:

Control Strip—Did you use a control strip from the wrong code number? Remember, if you change code numbers, you need to establish new aim values from the reference strip for that code number. Do the control-strip code numbers match those of the reference strip? Were the strips handled and stored properly?

Densitometer—Is it working properly? Is it calibrated properly? Did you use the correct filters?

First-Developer Time—Check the first-developer time with an accurate timer or stopwatch. Measure the time from the instant a particular part of the paper enters the first developer to the point at which it enters the first wash. The recommended first-developer time is 1 minute 15 seconds.

First-Developer Temperature—Check the first-developer temperature with a separate, accurate thermometer that is free of the processing machine. The recommended first-developer temperature is the temperature (in the range of 36.0 to $40 \pm 0.3^\circ\text{C}$ [96.8 to $104.0 \pm 0.5^\circ\text{F}$]) that you determined to achieve the correct process speed at start-up. Once you set that temperature, maintain it to within $\pm 0.3^\circ\text{C}$ ($\pm 0.5^\circ\text{F}$). Be sure other process variables are properly set before you adjust the first-developer temperature.

Contamination—Contamination of the first- or color-developer tank or replenisher solution by bleach-fix or a fixer can cause a large density and color shift.

Other Solutions—Check the times and temperatures of the color developer and bleach-fix. If they are different from those established at start-up, return them to start-up levels, and evaluate them with a control strip.

Improper Mixing—Was the first- and/or color-developer tank solution mixed properly? If the problem occurred with a fresh start-up, this is a possible cause.

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

- Did you use control strips with the correct code number?
- Did you plot the density values against the correct aim values?
- Is the densitometer operating properly?
- Were the time and temperature set correctly?
- Is the replenishment rate set correctly?

Checking for contamination or for correct mixing requires more time and effort. Unless you have good reason to suspect one of these causes, check them after you have checked the more easily verified causes. To help you determine the cause of the out-of-control condition, use the sections “Diagnostic Charts” and “Control-Chart Examples.” The chart on page 6 shows a typical control plot.

TAKING CORRECTIVE ACTION

When a density value plots outside the action limit, verify that plot by processing a second strip. Do this before you take any other action. Once it is verified, correct the problem. Do not wait until the process exceeds the control limit; when that happens, the process is already out of control. DO NOT process any more customer work until you correct the problem.

When more than one density value exceeds the action limit at the same time, check out the value that has the greatest deviation. Investigating and correcting this value usually corrects the problem. If it does not, check the value with the next greatest deviation.

Each of the diagnostic charts lists probable causes for a particular control-plot problem. Way to verify the cause and correct a problem are outlined. Once you have identified the cause and corrected it, you can use one of these three methods to deal with the symptoms of the problem.

Wait and Tolerate—If the control limits are not exceeded, you can continue processing. With this method, the problem condition is seasoned out of the process; it can be tolerated until the control value returns to the aim zone.

Dump Partially—You can partially dump a processing solution to reduce a problem condition. After a partial dump, bring the tank to full volume with a properly mixed tank solution; do not refill the tank with replenisher solution. The partial dumps may be from 5 to 10 percent of the tank volume for a minor problem and up to 50 percent or more for a significant problem. It is often better to make two small partial dumps rather than one large partial dump. This allows you to monitor the change with control strips after each dump. You can see the effects of diluting the problem solution with fresh working solution. Partial dumps will not relieve conditions such as bleach-fix contamination of first or color developer, sulfurization of bleach-fix, or first-developer contamination of color developer.

Dump Completely—When a solution has a serious problem, dump it completely and replace it with fresh working solution.

NOTE: When dumping a tank or replenisher solution, dispose of the solution in accordance with local environmental regulations.

WHAT DO YOUR PRINTS LOOK LIKE?

The D-max, HD-LD, LD, WD, and D-min control-chart plots identify many types of processing errors. You can also detect some types of processing errors by viewing the prints. Stain spots and physical marks indicate a particular type of problem. The following is a visual reference to processing errors.

PROBLEM	POSSIBLE CAUSE
Cyan stain	• First developer too diluted or exhausted
“Pink” stain	• Color developer exhausted (low utilization)
Minus-density spots	• Moisture condensation on cold paper • Air bubbles in first developer
Dirt particles in emulsion	• Inadequate wash times or clogged filters • No filters
Abnormal color	• Using mixing equipment not approved for photographic processing solutions • Bleach-fix contamination of first developer, color developer, or first wash appearance • Using mixing equipment not approved for photographic processing solutions • Bleach-fix contamination of first developer, color developer, or first wash • Using replenisher storage tanks without floating lids and dust covers • Interchange of floating lids in replenisher storage tanks • Failure to clean and wash chemical mixing equipment after the preparation of each mix

MAKING A VISUAL CHECK FOR RETAINED SILVER

You can also make a visual check for retained silver in your prints. Prints can retain silver if the bleach-fix is too dilute or is underreplenished, or if the bleach-fix time is too short or the temperature is too low. Excessive water carry-over, due to ineffective squeegees, can dilute the bleach-fix.

You can easily check your prints for retained silver by comparing the processed control strip with your reference strip with an infrared scope in a dark room. When you view the strips through the scope under infrared illumination, only silver images will be clearly visible; the dye images will be nearly invisible. If the image on the control strip is more apparent than the image on the reference strip when you view them with the infrared light source and scope, the control strip has retained silver. If you see no image (as in the reference strip), there is no retained silver. High levels of retained silver affect print quality, and can also give false signals to sensors used in automatic print cutters.

DIAGNOSTIC CHARTS

The diagrams in this section provide you with a step-by-step approach to diagnosing processing problems. Summary charts show which detailed chart to consult for your problem. The charts give probable causes and suggest corrective procedures.

Use the diagnostic charts along with the control chart patterns to identify causes and remedies for your process-control problem. To find a control-chart example that matches a problem, look for numerical identifications of control charts that match the diagnostic chart. (See page 23).

- Diagnostic Chart A shows the steps for a preliminary investigation of a problem; control-strip and densitometer evaluation.
- Diagnostic Chart B summarizes the problem as shown by the control strips. If more than one parameter is outside the tolerance, use the one that indicates the most severe condition. If correcting this does not solve the problem, investigate the other problem parameters. Chart B directs the investigation to more specific diagnostic charts.
- Diagnostic Chart C shows possible causes and corrections of a high D-min.
- Diagnostic Chart D shows possible causes and corrections of a high LD and WD.
- Diagnostic Chart E shows possible causes and corrections of a low LD and D-max.
- Diagnostic Chart F shows possible causes and corrections of a low D-max

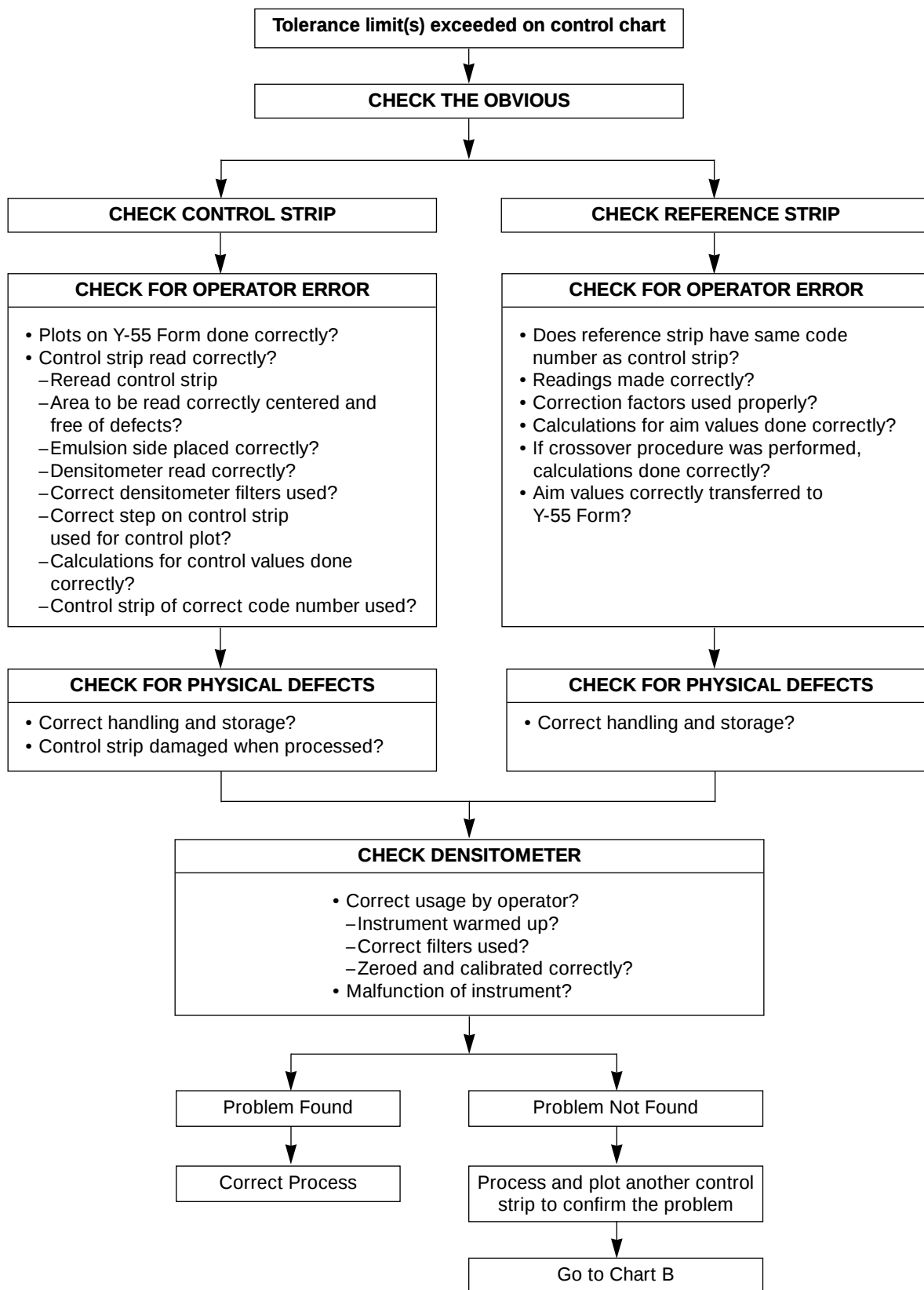


Chart B
Summary-Control Plots

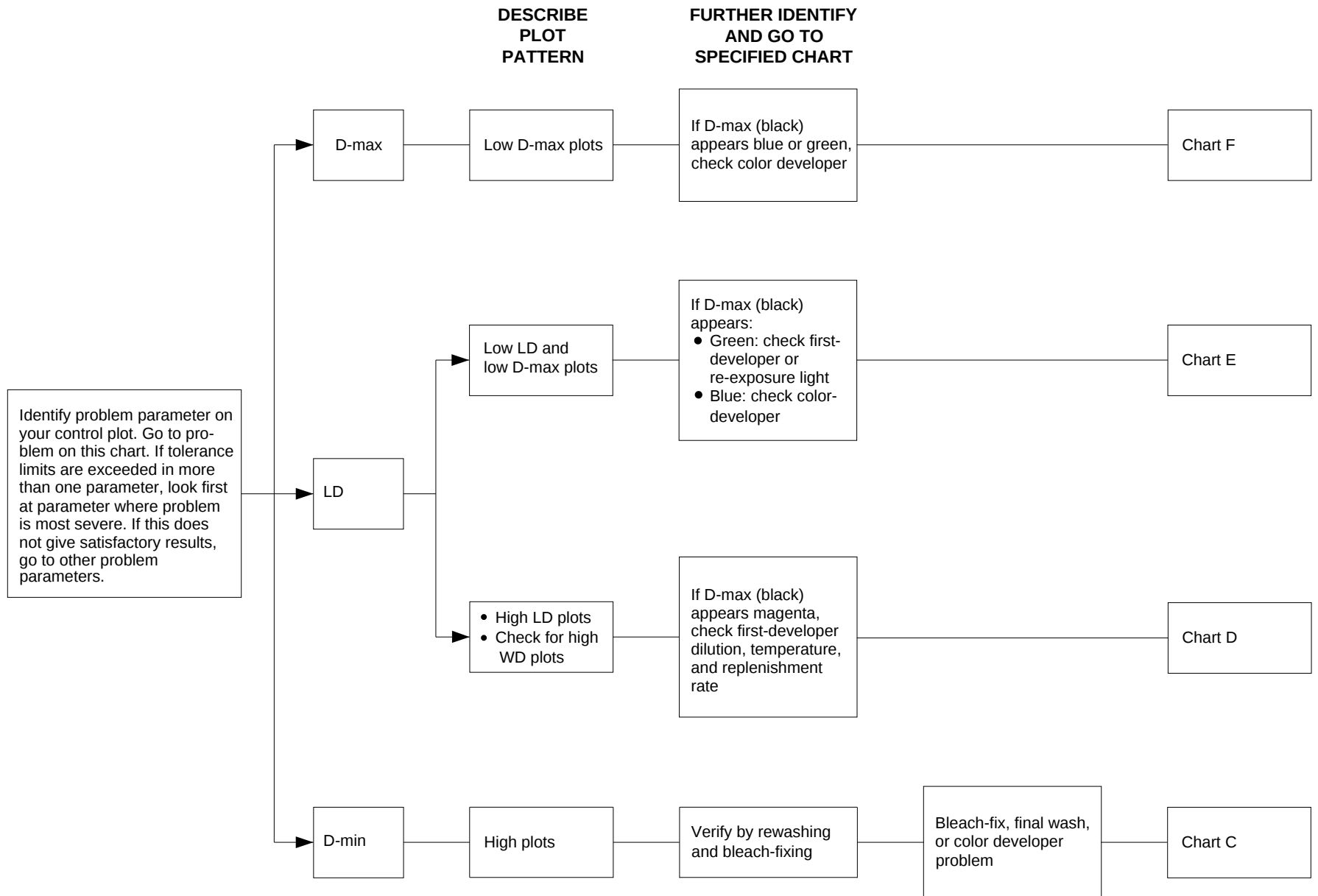


Chart C

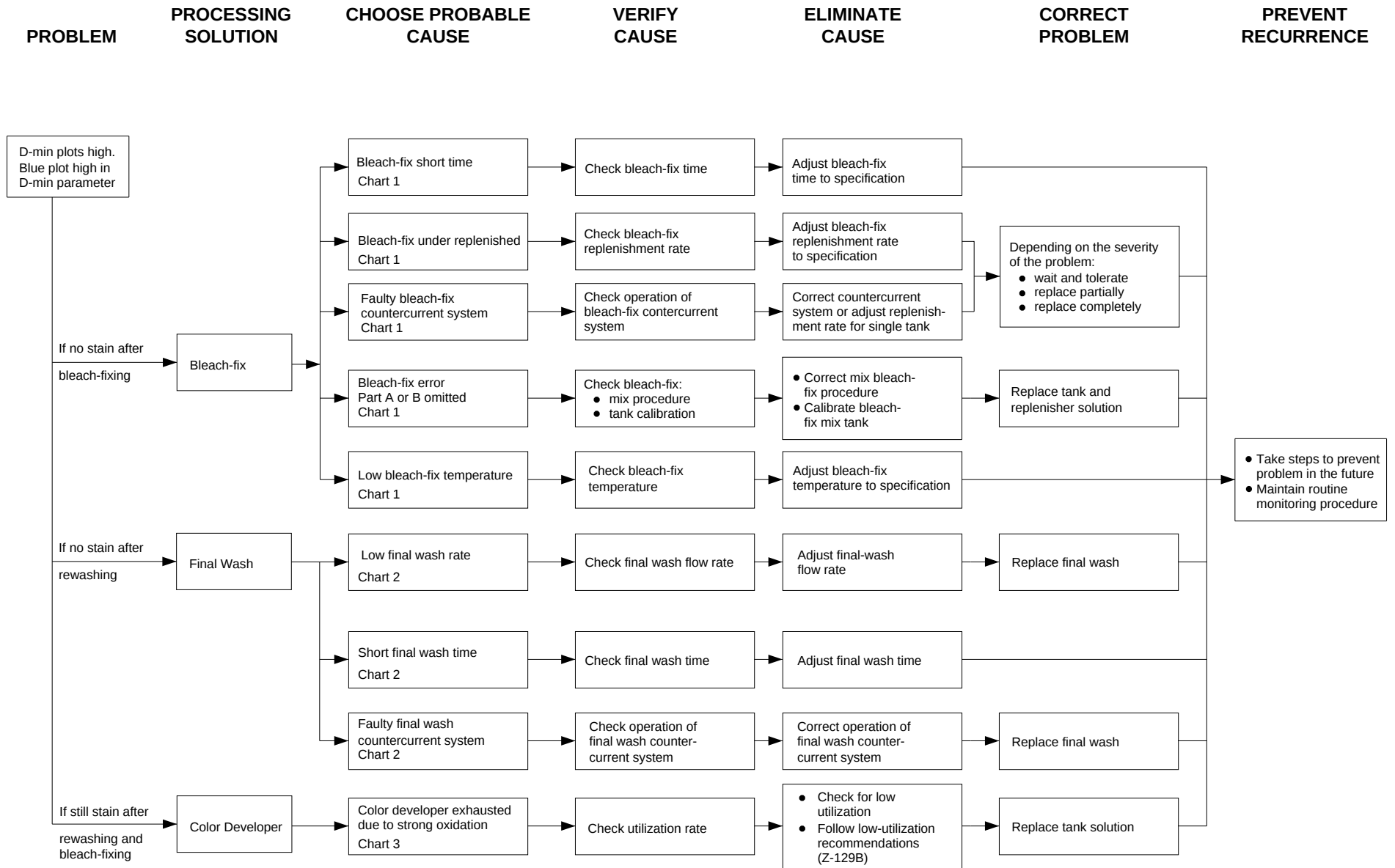


Chart D

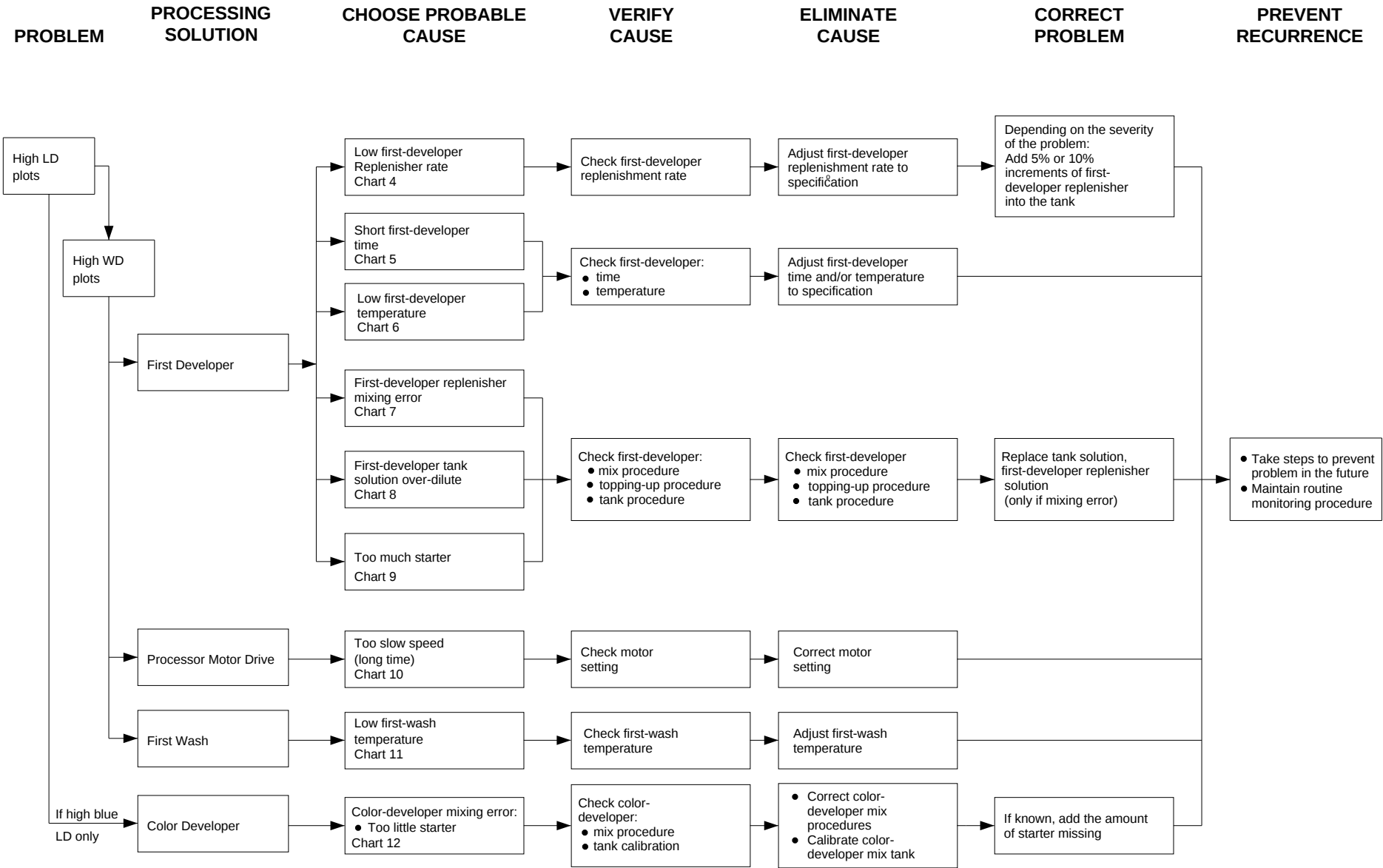


Chart E

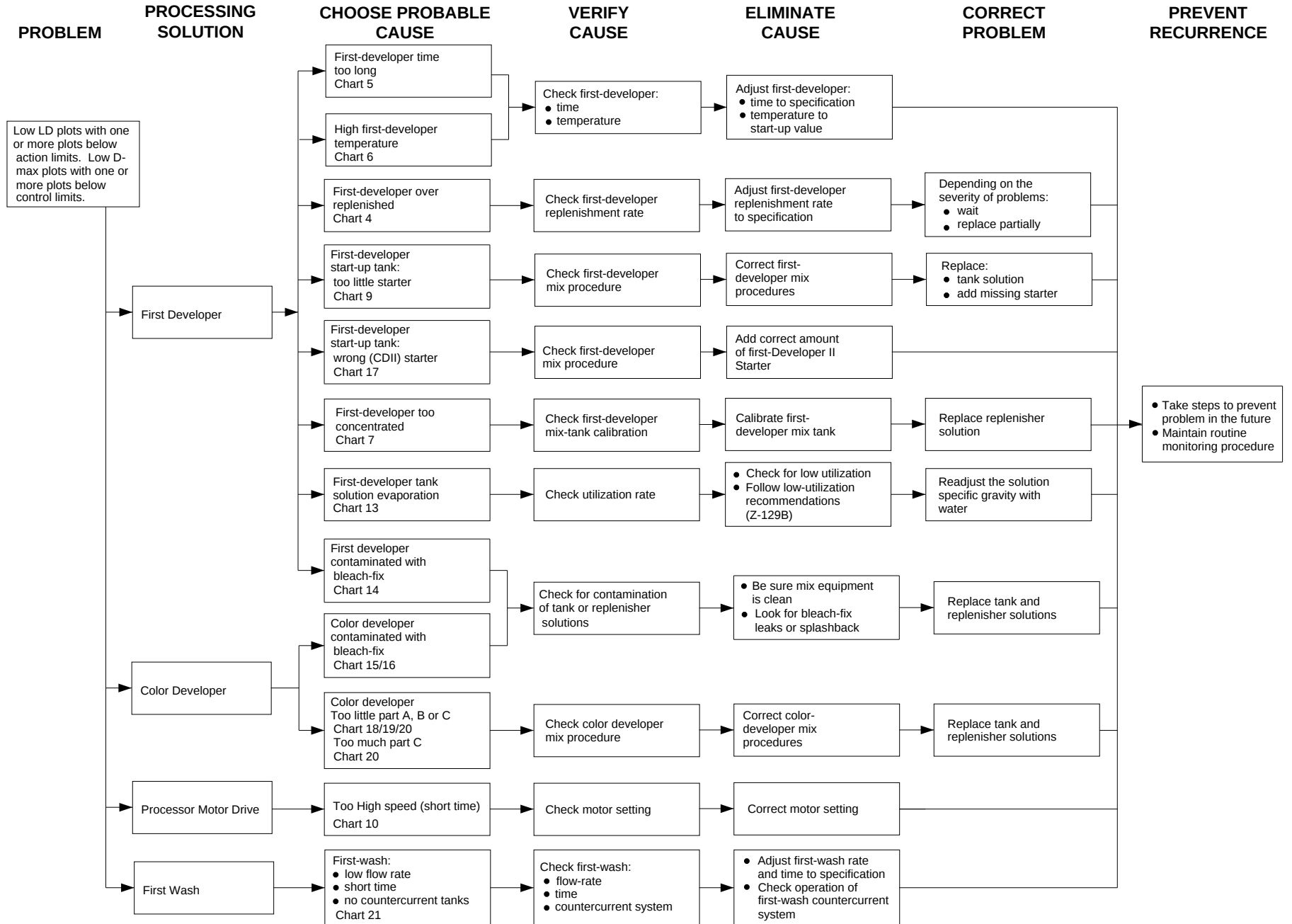
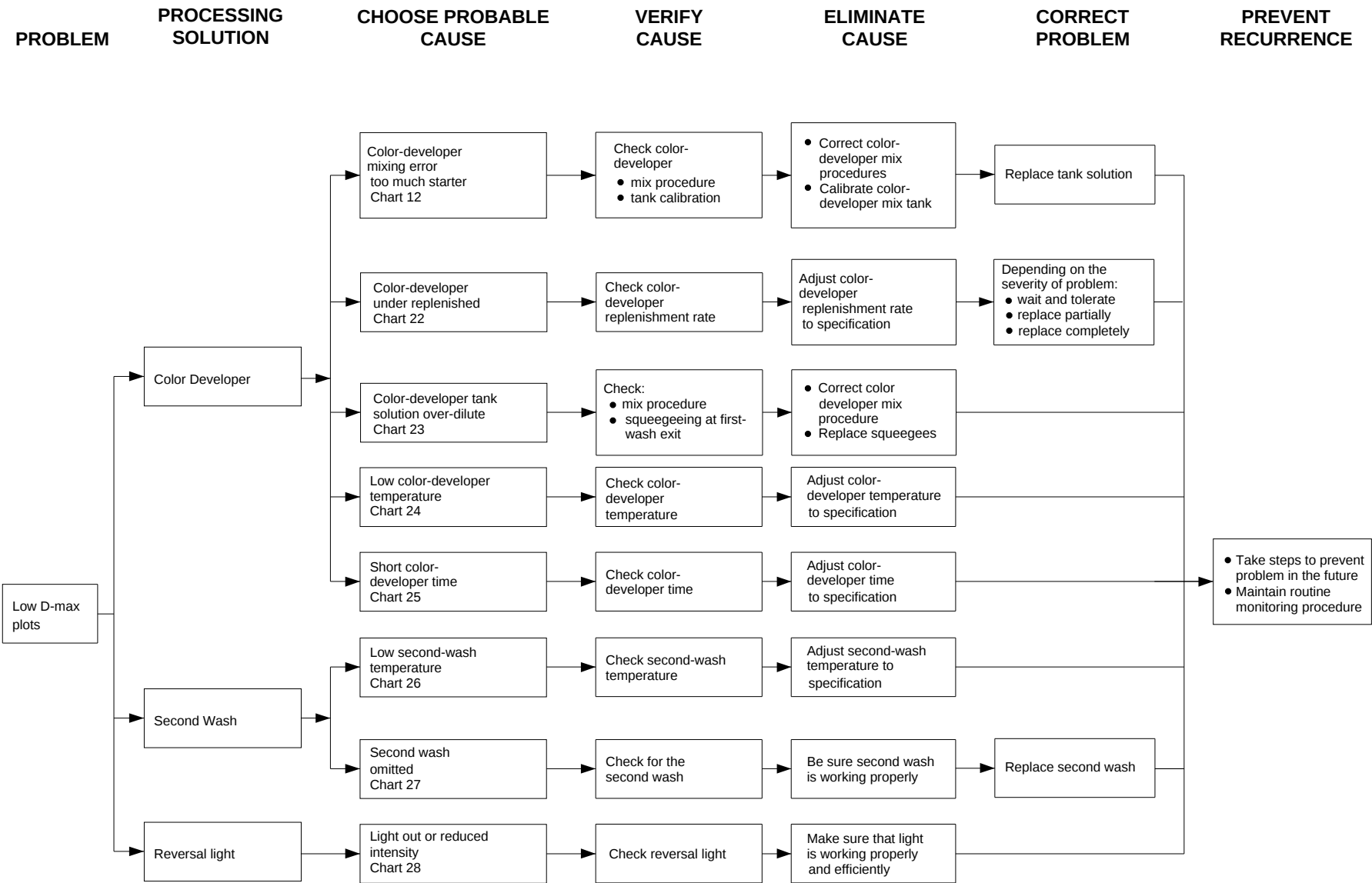


Chart F



CONTROL-CHART EXAMPLES

These 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 the conditions of processing. Also, more than one problem may be affecting your plots. In some cases, the control plots show processes that are not out of control or do not require corrective action. They are included to indicate the sensitivity and directional influence these conditions can have. The number of stars (*) indicates the likelihood of that problem occurring, with a single star indicating the lowest probability and three stars, the highest.

Locate the examples which most closely match your plotted density values. See the list of process variables and their corresponding control-chart patterns, and compare the control-chart patterns to your process-control plots. The letter identifications correspond to the letter identifications of the diagnostic charts for easy cross-reference.

Diagnostic Chart	Control Chart	Process Step	Condition	Probability
C High D-min	1	Bleach-Fix	Short time	*
			Low temperature	*
			Underreplenishment	***
			Faulty countercurrent	***
			Mix error	*
	2	Final wash	Part A or B omitted	*
			Low flow rate	*
			Short time	*
			Faulty countercurrent	*
D High LD/WD (High D-max)	3	Color developer	Oxidation	***
	4	First developer	Underreplenishment	**
	5		Short time	*
	6		Low temperature	***
	7		Mixing error/concentration	*
	8		Dilution	*
	9		Mixing error/too much starter	*
	10		Processor drive motor/low speed	**
	11	First wash	Low temperature	*
	12	Color developer	Mixing error/too little starter	*
E Low LD (Low D-max)	5	First developer	Long time	*
	6		High temperature	***
	4		Overreplenishment	**
	9		Mixing error/too little starter	*
	17		Mixing error/wrong (CDII) starter	*
	7	Color developer	Mixing error/too concentrated	*
	13		Excessive tank solution evaporation	***
	14		Contaminated with bleach-fix	**
	10		Processor drive motor/too high speed	**
	18		Mixing error/too little Part A	*
	19		Mixing error/too little Part B	*
	20		Mixing error/too little Part C	*
	20		Mixing error/too much Part C	*
	15		Contaminated with bleach-fix	**
	16		Contaminated with first developer	**
	21	First wash	Low flow rate	***
			No countercurrent tanks	***
			Short time	***
F Low D-max	12	Color developer	Mixing error/too much starter	*
	22		Underreplenishment	**
	23		First wash/ineffective squeegees	***
	24		Low temperature	***
	25	Second wash	Short time	*
	26		Low temperature	*
	27		No second wash	*
	28	Reversal light	Reversal light out	**

HIGH D-MIN—LOW D-MIN

Bleach-Fix—Short Time*

Bleach-Fix—Low Temperature*

A short time or a temperature that is too low (below 30°C [86°F]), in the bleach-fix, prevents complete removal of the silver. You will see this in the control plots as an increase in D-min and a separation of red from green and blue in the D-max. Inadequate bleach-fix activity is most apparent in the D-min step, where the metallic silver is most visible.

Problem Correction

Check the time and temperature of the bleach-fix recorded at start-up.

An incorrect time can be caused by an incorrectly adjusted processor rack or a faulty machine drive.

A low temperature can be caused by failure to allow the bleach-fix to reach operating temperature, by a faulty temperature, by a faulty temperature controller, or by the use of replenisher that is too cold.

If you have checked these possibilities and they are not the cause, check the bleach-fix replenishment rate.

Bleach-Fix—Underreplenished***

Bleach-Fix—Faulty Counter-current Flow***

If the bleach-fix is underreplenished, the concentration of some components will decrease, silver in the bleach-fix tank solution will increase, and bleach-fix activity will be too low.

A faulty counter-current flow in the bleach-fix also produces a loss of bleach-fix activity.

Problem Correction

How quickly you control plots indicate an incorrect replenishment rate depends on the tank volume, the machine speed, and the amount of paper or material processed. Recheck the average production that you used to calculate the replenishment rate. Check the replenishment rate as described in the processor manual: Adjust if it is necessary. Check that counter-current flow in the bleach-fix meets recommendations. If the flow is faulty, you will need to use higher bleach-fix replenishment rates to compensate. A single bleach-fix tank requires 500 mL/m² (46 mL/ft²).

continued on next page

Chart 1

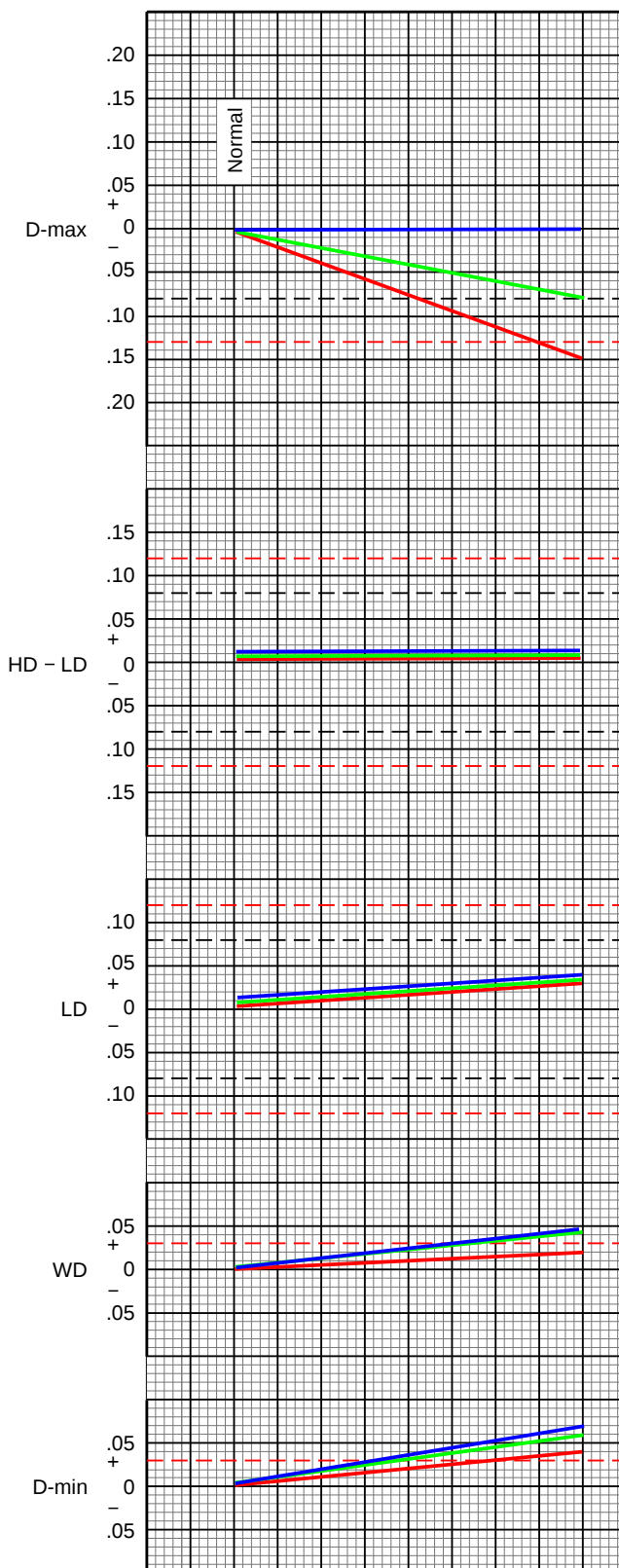


Chart 1 (continued)

Mixing Error—Bleach-Fix— Part A or B Omitted*

If you completely omit Part A or Part B when you mix the bleach-fix replenisher for use as tank solution, no silver removal will take place: The control strip will be totally black. If you use the solution as a replenisher, the bleach-fix tank solution will gradually weaken. The first indication will be high D-min, indicating a high amount of residual silver.

Problem Correction

Replace the bleach-fix tank and replenisher solutions.

HIGH D-MIN

Final Wash—Low Flow Rate*

Final Wash—Short Time*

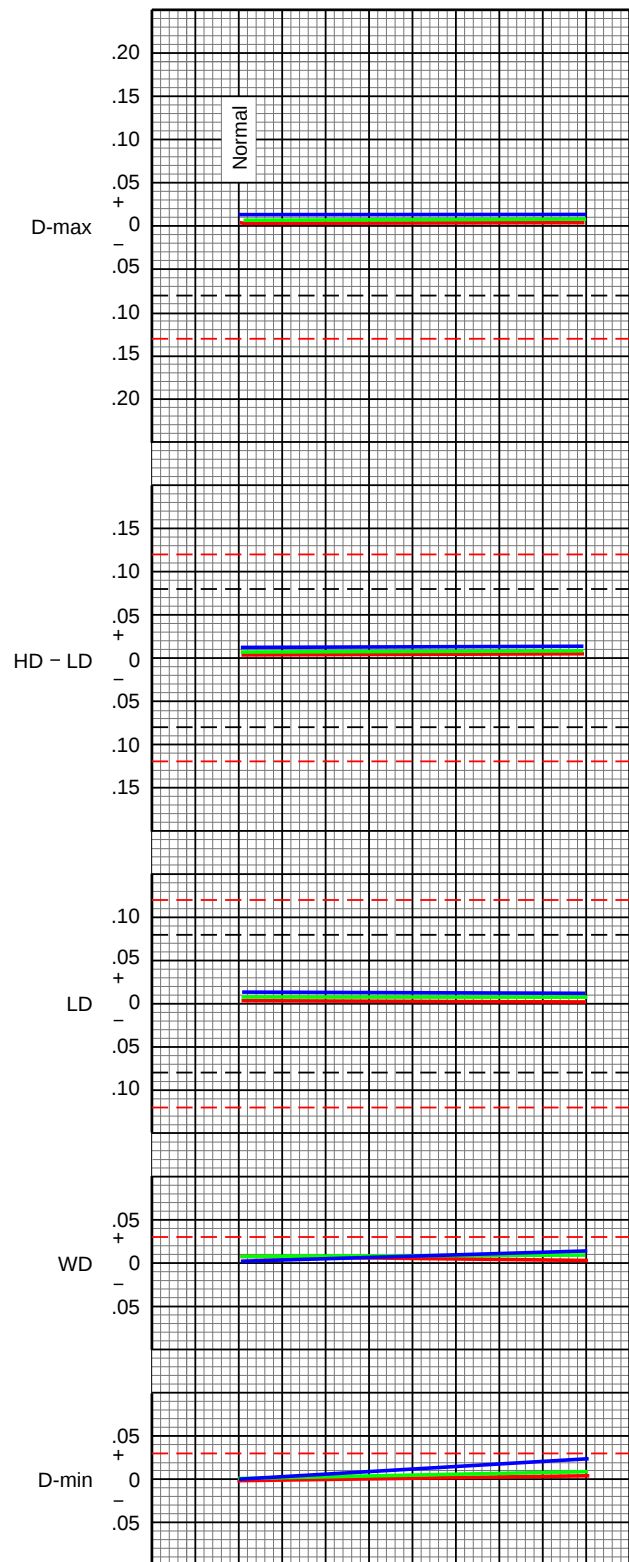
Final Wash—Faulty Counter-current Flow*

The final wash removes remaining traces of silver salts. Inadequate washing allows residual silver salts to remain in the emulsion. This can cause increased density in the D-min, especially in the blue layer. Do not use less than the minimum flow rate and wash times. Use at least two counter-current-flow wash tanks for the final wash.

Problem Correction

Check the flow rate of the final wash. It should be at least 5000 mL/m² (465 mL/ft²). A clogged water filter may cause poor flow rate. Change the filter frequently. Check the final-wash time; it should be at least 2 minutes 15 seconds. If the time is too short, adjust the racks or machine transport speed. You can correct a high D-min problem caused by inadequate washing by rewashing the prints.

Chart 2



LOW D-MAX, LD HIGH D-MIN

Color Developer—Oxidation***

Partly exhausted color developer can cause a decrease of blue D-max and an increase of blue and green D-min. This occurs most frequently in roller-transport processors. The features unique to roller-transport processors make them particularly susceptible to solution oxidation. These processors also often have a low rate of use, which increases the likelihood of developer oxidation. See KODAK Publication No. Z-129B, *Using KODAK EKTACHROME R-3 Chemicals in Continuous and Roller-Transport Processors*, for low-utilization recommendations.

Problem Correction

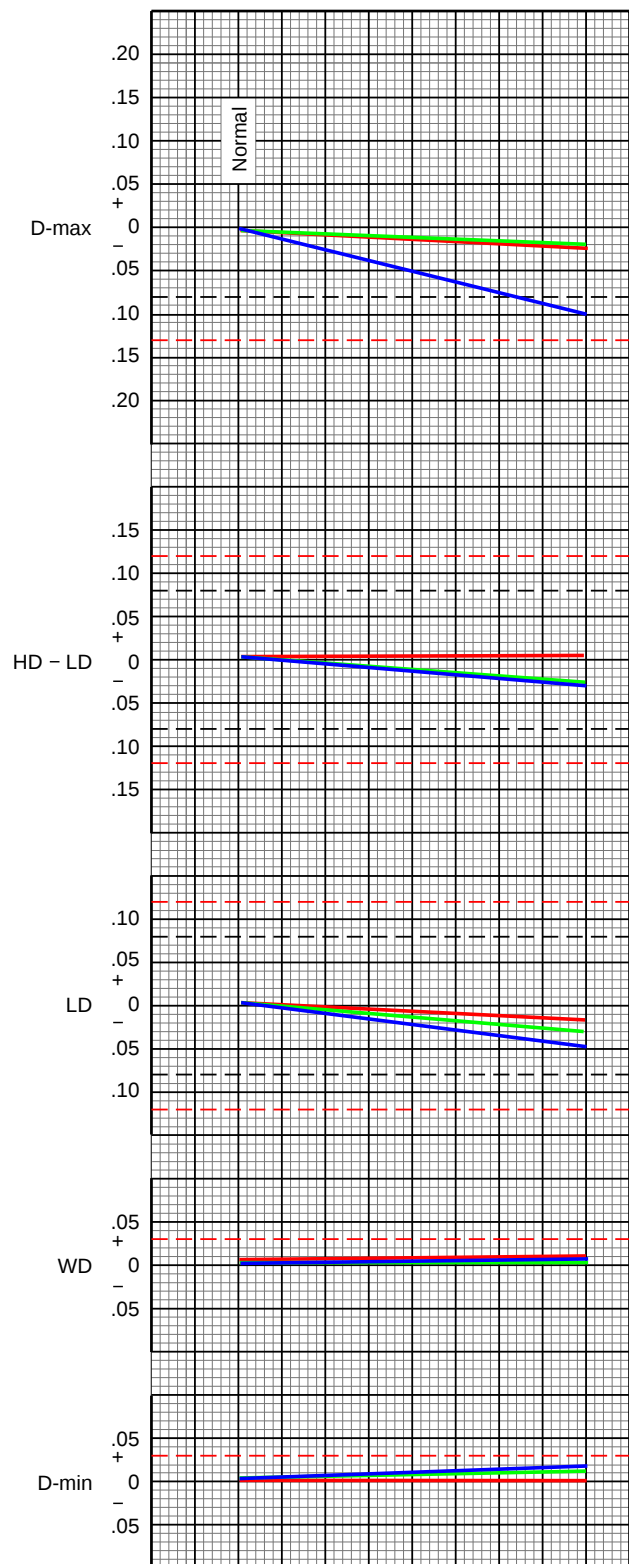
A roller-transport processor may develop “pink” stain after long use. You can correct the problem by using a charcoal filter in the color-developer recirculation system for a day or two (see page 11).

You cannot correct an exhausted color-developer tank solution. Replace it with a fresh mix. You cannot correct paper or material processed in exhausted developers by additional washing or processing.

Check the area around the developer tank for high ventilation; this promotes oxidation. Also, make sure there are no air leaks in your recirculation system.

Use of floating lids minimizes replenisher oxidation. If the color developer replenisher has been stored improperly or for too long, replace it. See KODAK Publication No. Z-129A, *KODAK EKTACHROME R-3 and R-3000 Chemicals*, for replenisher storage recommendations.

Chart 3



HIGH D-MAX, HD-LD, LD, WD

First-Developer—Replenishment Rate**

First-developer activity varies with the replenishment rate. An incorrect replenishment rate will not cause an immediate change, but its effect will appear over a period of time. How quickly the change occurs depends on the processor tank volume, the machine speed, and the amount of paper or material processed.

A low first-developer replenishment rate causes a decrease in first-developer activity. More dye will be formed in the color developer. You will see this in the control plots as an increase in LD and D-max. You may also see an increase in the WD plot.

A slightly high first-developer replenishment rate usually does not affect the process.

Problem Correction

If you suspect that replenishment is the problem:

1. Check that the replenishment rate is set correctly.
2. If you set your replenishment rate for the average paper width being processed, are your calculations correct?
Does paper width vary seasonally? Is the process properly replenished for the number of strands processed? Use this calculation to check your replenishment rate.

$$\begin{array}{rclcl} \text{Flow} & = & \text{Processor} & & \text{Paper} & & \text{Replenishment} \\ \text{Rate} & & \text{Speed} & \times & \text{Width} & \times & \text{Rate} \\ \text{mL/min} & & (\text{ft or m/min}) & & (\text{ft or m}) & & (\text{mL/ft}^2 \text{ or m}^2) \end{array}$$

3. Was paper processed without replenishment? Check.
4. Check for mechanical problems in the replenishment system. Is the system replenishing at a constant rate?
5. Check the metering pump to see if it is operating properly and is correctly calibrated.

continued on next page

Chart 4

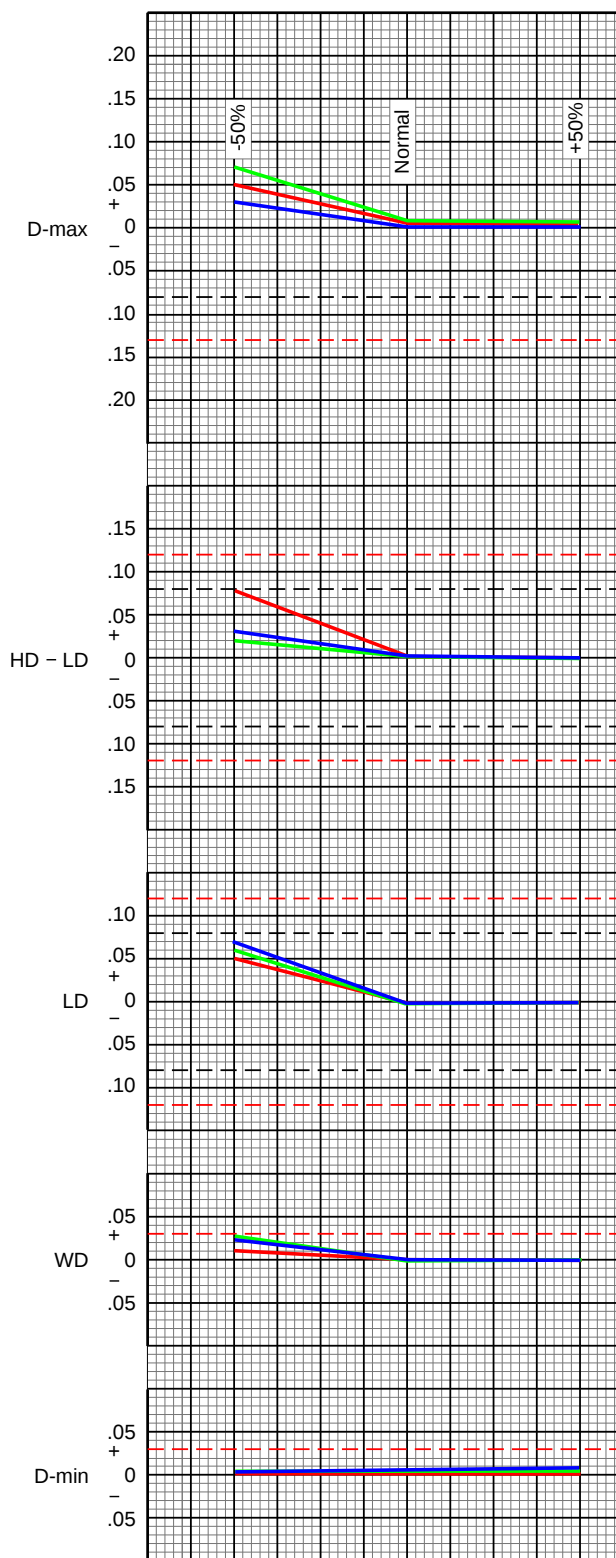


Chart 4 (continued)

Note that the recommended replenishment rates are starting points only. The exact rate depends on the type of processor, mixing and storage conditions for the replenisher, and how accurately operating conditions, such as development time and temperature, are maintained.

Determine your exact rate by monitoring the process with control strips. Adjust this rate according to your control plot. However, do not adjust the rate to “chase” small changes in the control plot. Once your process is in control, use the replenishment rate that you’ve determined; don’t change it unless processor utilization changes.

If *underreplenishment* is the cause of the problem, adjust the replenishment rate to the recommended rate. Then adjust the tank solution. Remove enough solution so that you can add replenisher. Add replenisher in 5- to 10- percent increments until the process is back in control. After each addition, recirculate the developer for approximately 10 minutes before you process another control strip. When the process is back in control, resume processing. If the process is still not in control after you have replaced 20 percent of the tank solution with replenisher, replace the tank solution with a fresh mix.

Once the process is back in control, return to normal processing conditions.

To avoid replenishment problems, check the replenisher settings regularly to be sure that the correct rates and the tank volumes are maintained. Always adjust the rates for the paper widths you are processing, and replenish only when you are processing paper or material.

HIGH D-MAX, LD-LD, LD, WD LOW D-MAX, LD-LD, LD, WD

First Developer—Time*

First-developer activity varies directly with time.

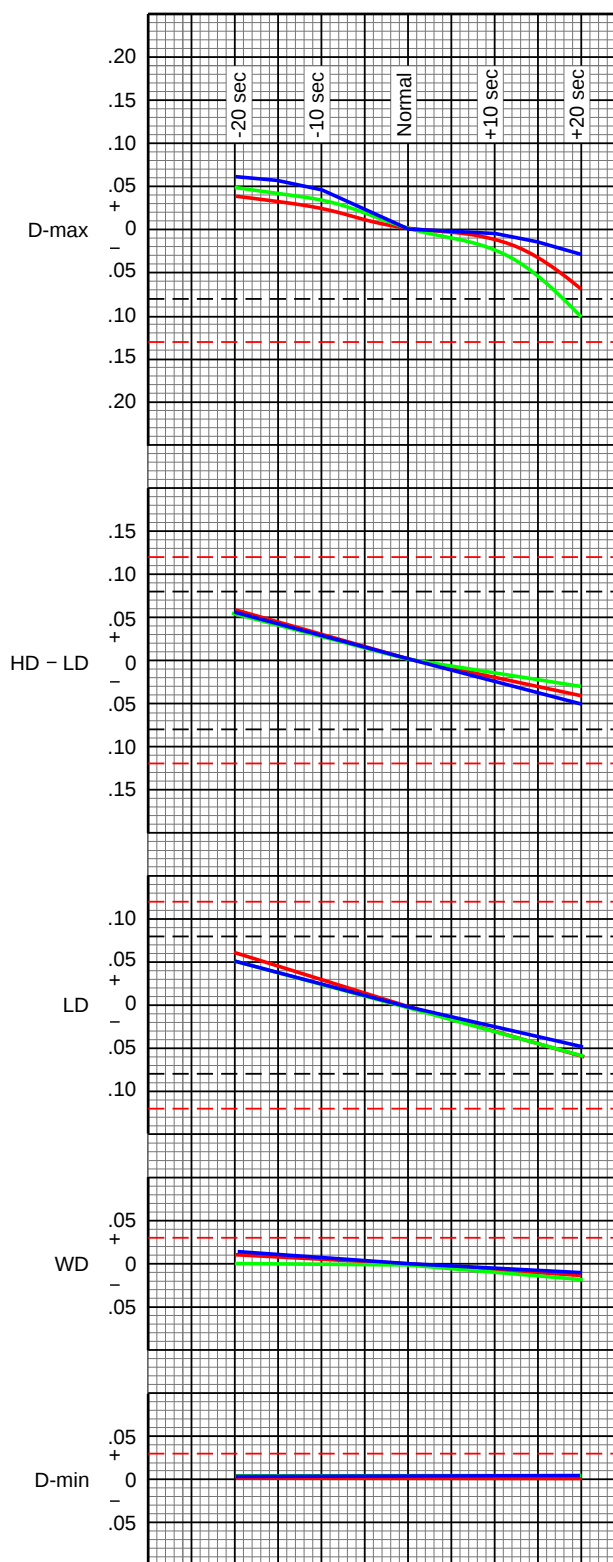
A first-developer time that is too short causes a decrease in first-developer activity, and allows more dye to be formed in the color developer. In the control plots, you will see this as an increase in LD, and D-max. You may also notice a slight increase in the WD plot for very short times.

A first-developer time that is too long causes an increase in first-developer activity, and less dye will be formed in the color developer. In the control plots, you will see this as a decrease in LD, and D-max.

Problem Correction

Time variations are unlikely to occur in continuous processors because paper-immersion time is primarily determined by the drive motor. Such variations are most likely to occur if the rack positions are changed, such as after cleaning or rethreading the processor. If your processor has a variable-speed motor, be sure that the motor setting has not been changed.

Chart 5



HIGH D-MAX, LD LOW D-MAX, LD

First Developer—Temperature***

First developer activity varies directly with temperature. Temperature is critical; a temperature even slightly above or below standard will cause a significant change in first-developer activity.

A first-developer temperature that is too low causes a decrease in first-developer activity and allows more dye to be formed in the color developer. In the control plots, you will see this as an increase in LD and D-max.

A first-developer that is too high causes an increase in first-developer activity and allows less dye to be formed in the color developer. In the control plots, you will see this as a decrease in LD and D-max (especially green).

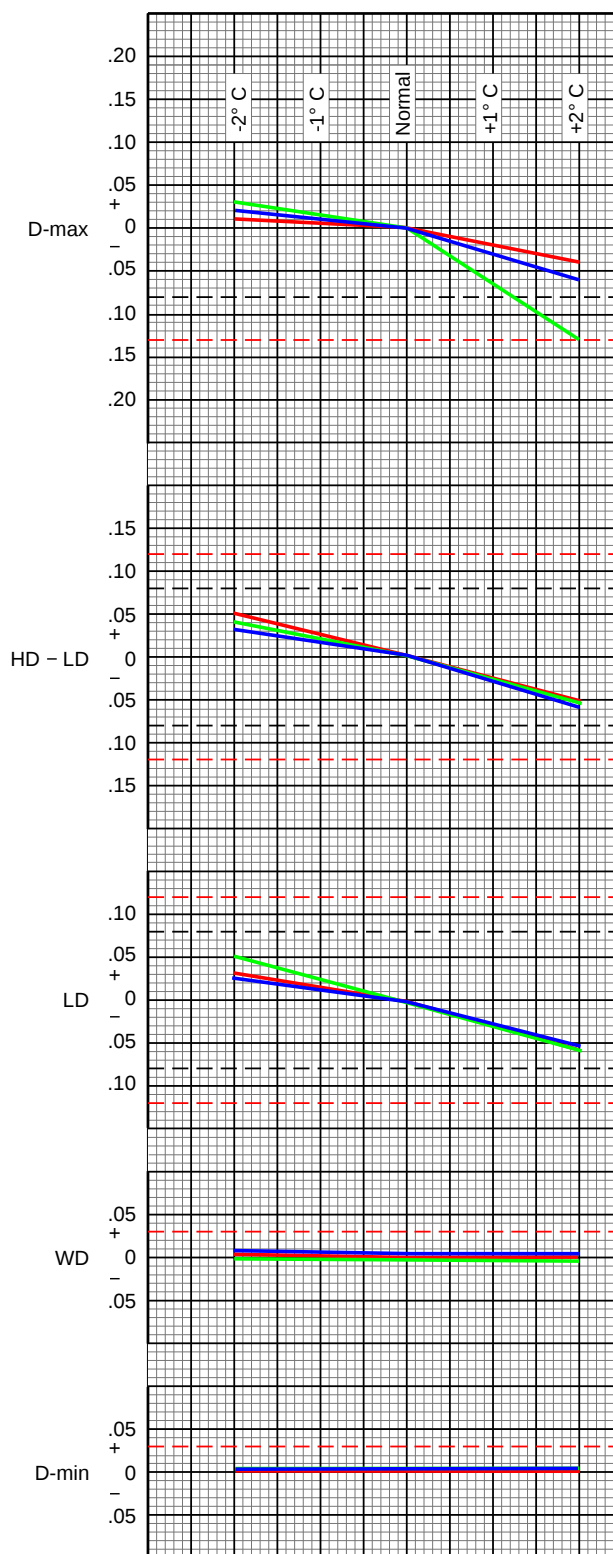
Refer to Z-129B, page 10, for temperature adjustments when initially setting up your processor.

Problem Correction

With an accurate, calibrated thermometer, check the first-developer temperature at startup and at several other times when the processor is operating. The temperature must be within $\pm 0.3^{\circ}\text{C}$ ($\pm 0.5^{\circ}\text{F}$) of your standard. At startup, turn on the pumps far enough in advance of processing to allow the solutions to reach the normal processing temperature. Be sure that the recirculation pump is operating properly.

Out-of-control problems that are caused by temperature fluctuations are often difficult to diagnose. Problems caused by electrical or equipment malfunctions can appear and disappear rapidly.

Chart 6



HIGH D-MAX, HD-LD, LD, WD LOW D-MAX, HD-LD, LD

First-developer—Concentration— Mixing Error*

Incorrect solution concentration is usually caused by mixing errors. These can occur if you simply add an incorrect amount of water or use an incorrectly calibrated mix tank. You can use specific-gravity measurements to verify the first-developer concentration (see *KODAK Publication No. Z-129A, KODAK EKTACHROME R-3 and R-3000 Chemicals*).

If the first-developer tank solution is *too dilute*, you will see this in the control plots as an increase in LD (especially red), HD-LD, and D-max. You will also see a slight increase in the WD (blue) plot for strong dilutions.

If the first-developer tank solution is *too concentrated*, you will see this in the control plots as low LD, HD-LD, and D-max (especially green).

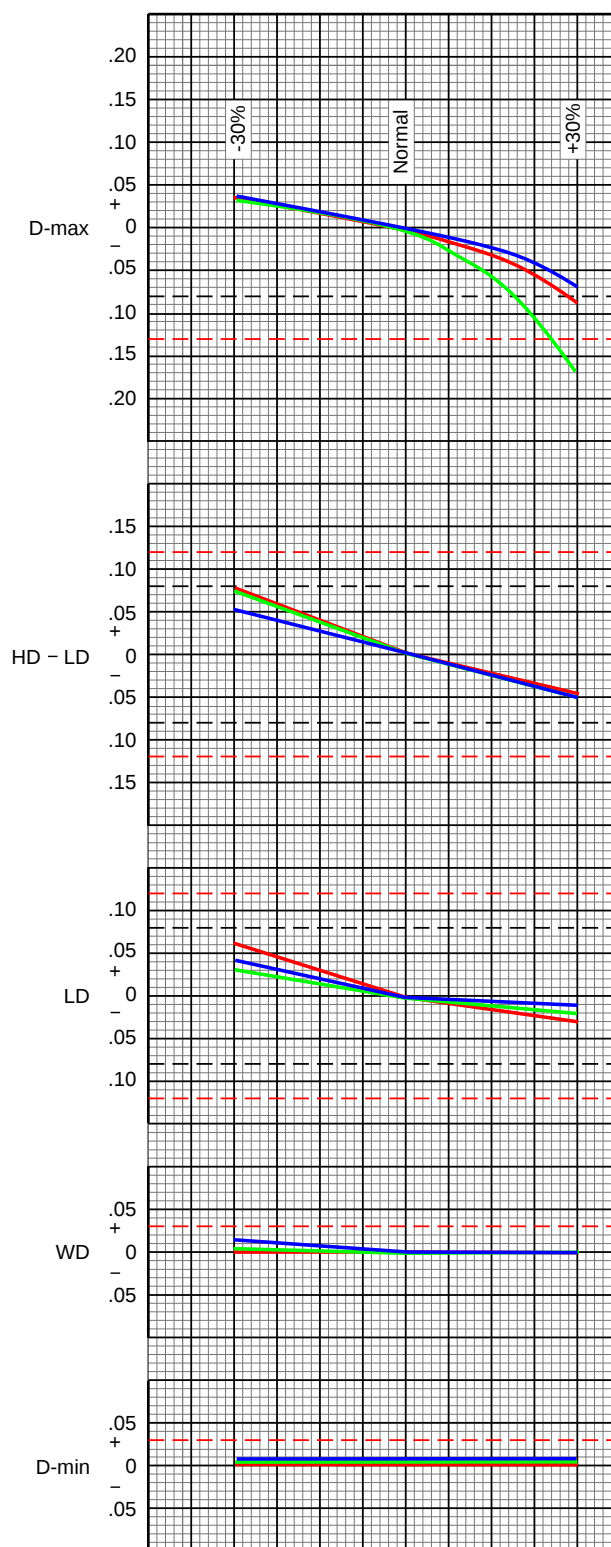
Problem Correction

Check your mixing procedures. Was the amount of water measured incorrectly? Check the calibration of your mix tanks.

If you can determine the exact amount of the error, you can add first-developer concentrate to correct a mix that is too dilute, or add water to correct an overconcentrated tank. You can use specific-gravity measurements as a guide.

If you cannot determine the amount of error, mix a new first-developer replenisher and make a new first-developer tank solution.

Chart 7



HIGH D-MAX, HD-LD, LD, WD

First Developer—Faulty Topping-up Procedure— Dilution*

First-developer activity varies directly with its concentration. Add just enough water to bring the tank solution to the overflow level. Adding excess water will dilute the first-developer tank solution.

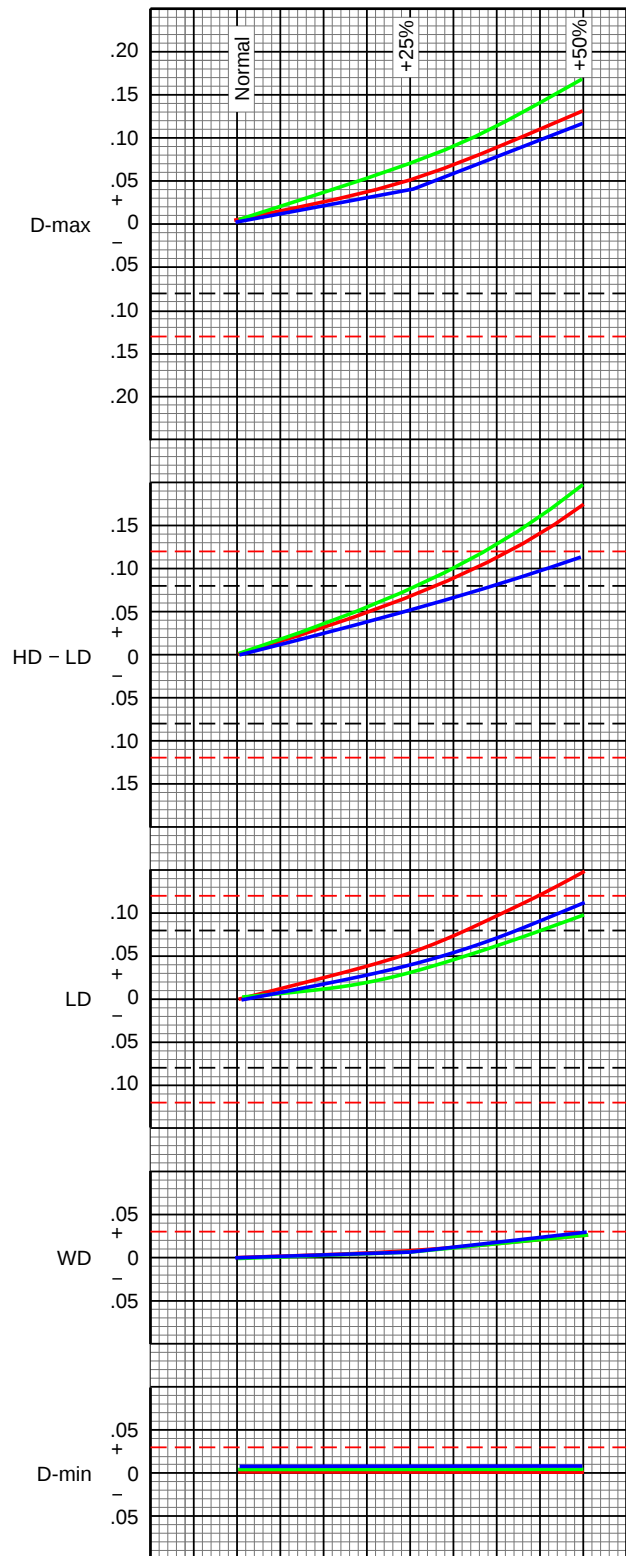
Significant evaporation of tank solutions occurs when a process is shut down overnight or is on standby for an extended period of time.

In the control plots, you will see this dilution as an increase in LD, HD-LD, and D-max (especially green). You may also notice a slight increase in the WD plot for strong dilutions.

Problem Correction

It is difficult to correct a dilute first-developer tank solution. Dump and replace with fresh first-developer tank solution.

Chart 8



HIGH D-MAX, HD-LD, LD, LD LOW D-MAX, HD-LD, LD

First Developer—Mixing Error— Too Little/Too Much Starter Solution*

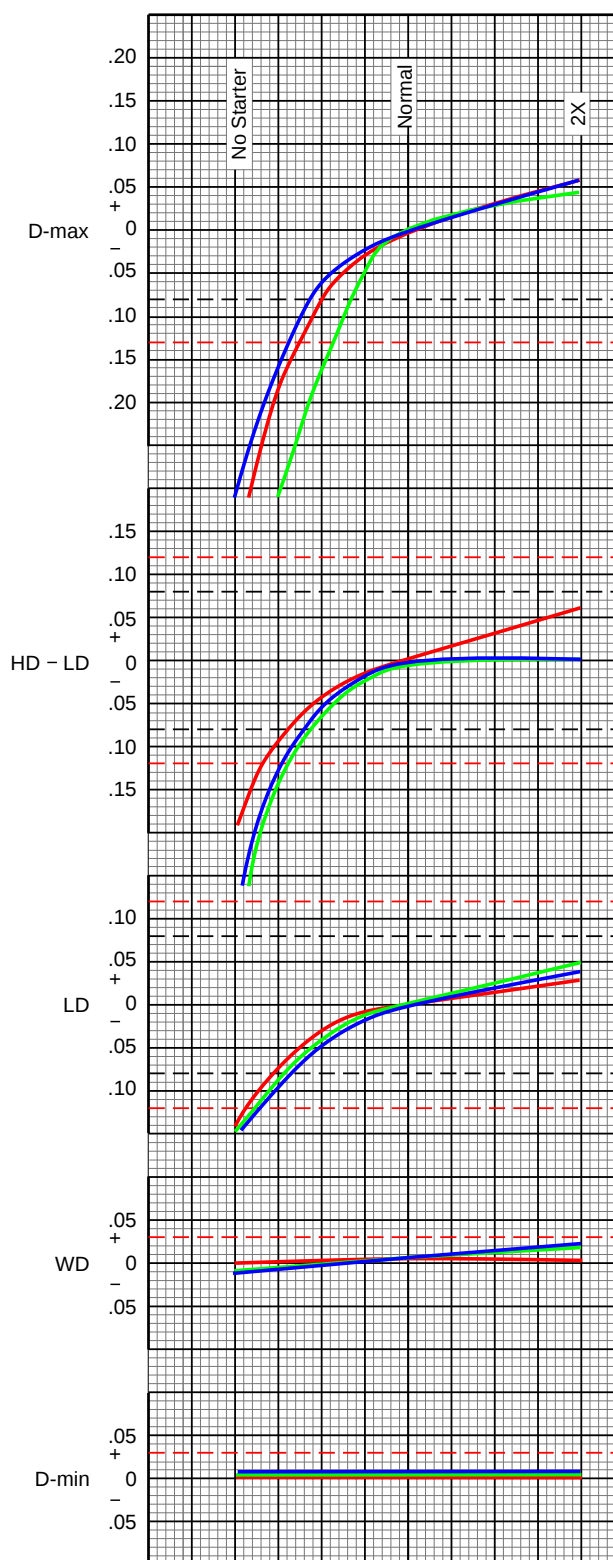
The amount of EKTACHROME R-3 First Developer II Starter affects the activity of the first developer. Too much starter solution causes a decrease in first-developer activity. In the control plots, you will see this as an increase in WD, LD, HD-LD and D-max.

Too little starter solution causes an increase in first-developer activity. In the control plots, you will see this as a decrease in WD, LD, HD-LD and D-max.

Problem Correction

If too much starter was used, replace the mix with one that is correctly made. If too little starter was used and you know the amount that is missing, add the correct amount of starter. If you do not know the amount of starter missing, make a new mix.

Chart 9



HIGH D-MAX, HD-LD, LD, WD LOW HD-LD, LD

Processor Drive Motor-Speed**

Activity of the first developer, color developer and bleach-fix varies directly with time. Separate time variations of these various processing steps are unlikely to occur in continuous processors because paper immersion time is primarily determined by the drive motor speed.

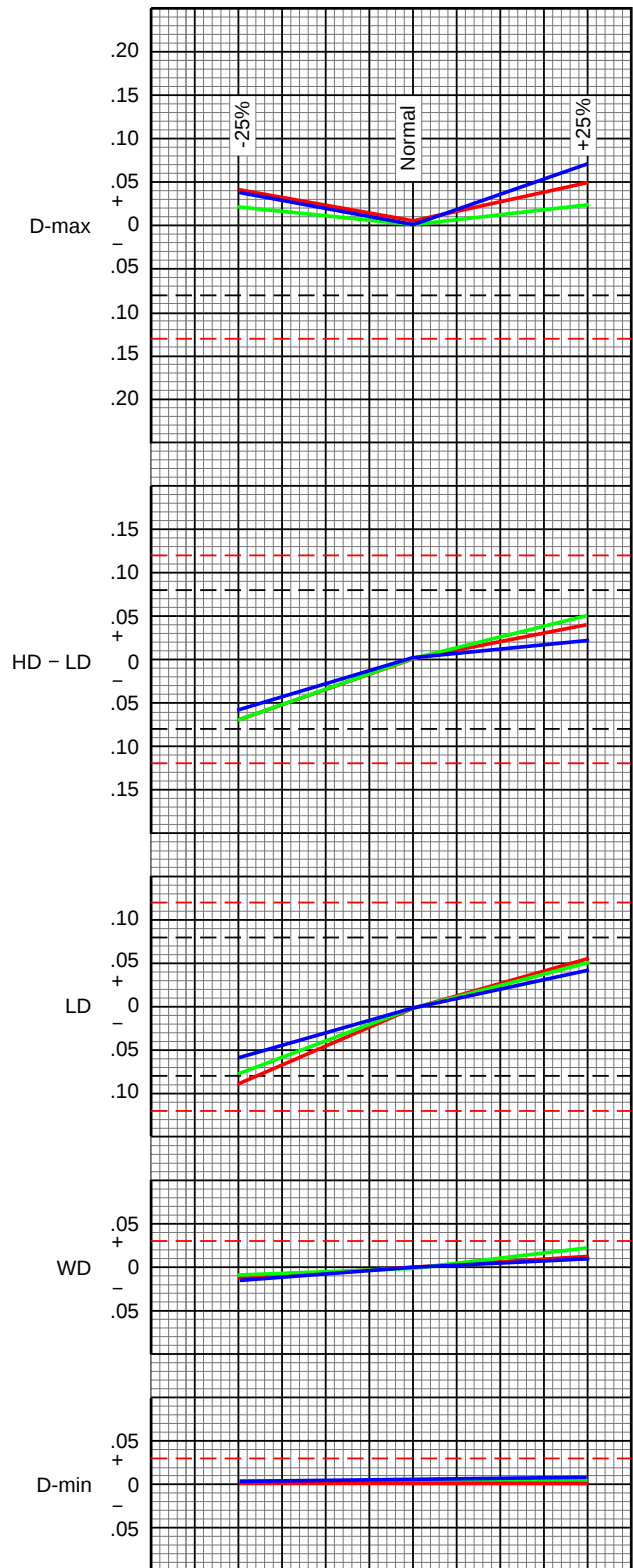
If the overall speed of the processor is too high or too low, the effects you notice are a combination of the various effects from the first-developer, color-developer, and bleach-fix time variations.

If the processor speed is too high, the overall processing time is too short. In the control plots, you will see this as an increase in D-max, HD-LD, LD, and WD.

Problem Correction

If your processor has a variable speed motor, be sure that the motor setting has not been changed.

Chart 10



HIGH HD-LD, LD

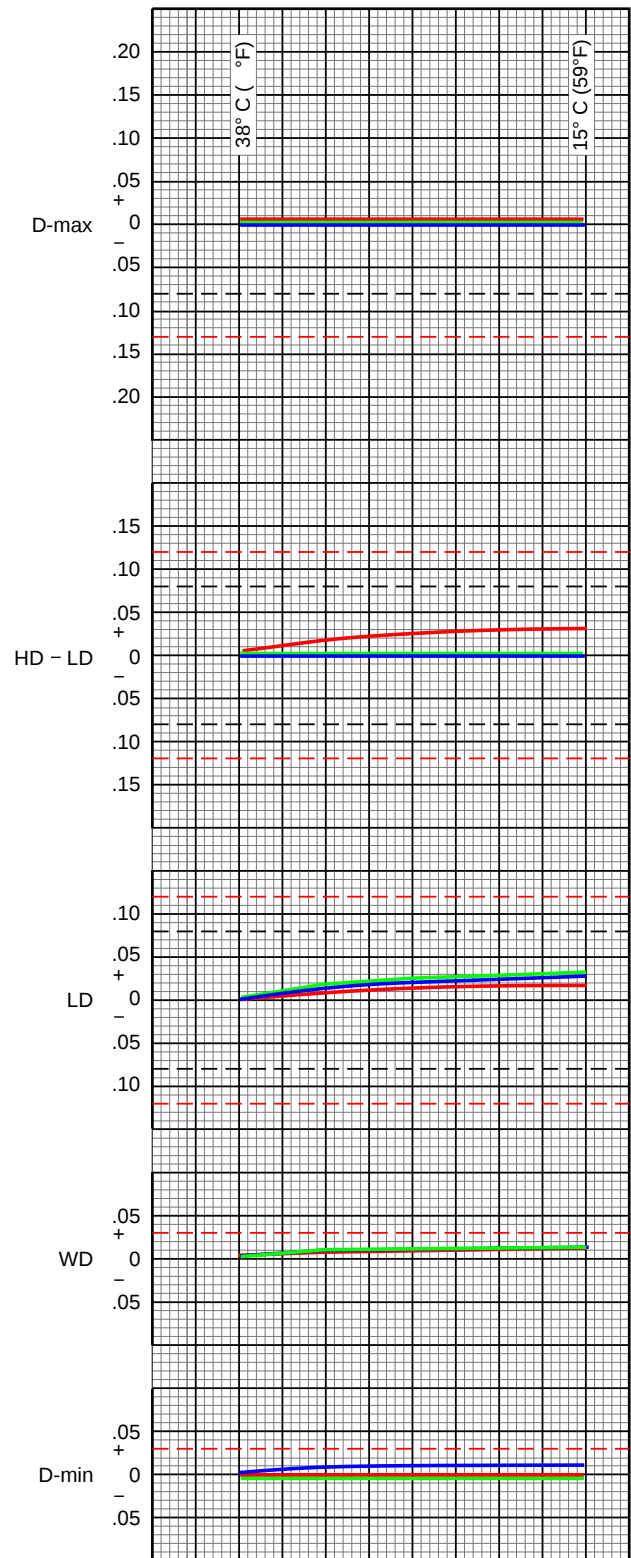
First Wash—Temperature*

Low temperature in the first wash may reduce first-developer activity by stopping the development too quickly. This is an immediate effect which results in an increase in LD and HD-LD red. Besides a low temperature water supply, you also may have too low a temperature in the first wash when the processor is not used for a long time during the day. The first-wash low-temperature limit is critical and must not be lower than 35°C (95°F).

Problem Correction

Check the water temperature of the first wash often and adjust it if necessary.

Chart 11



LOW D-MAX, HIGH LD

Color Developer

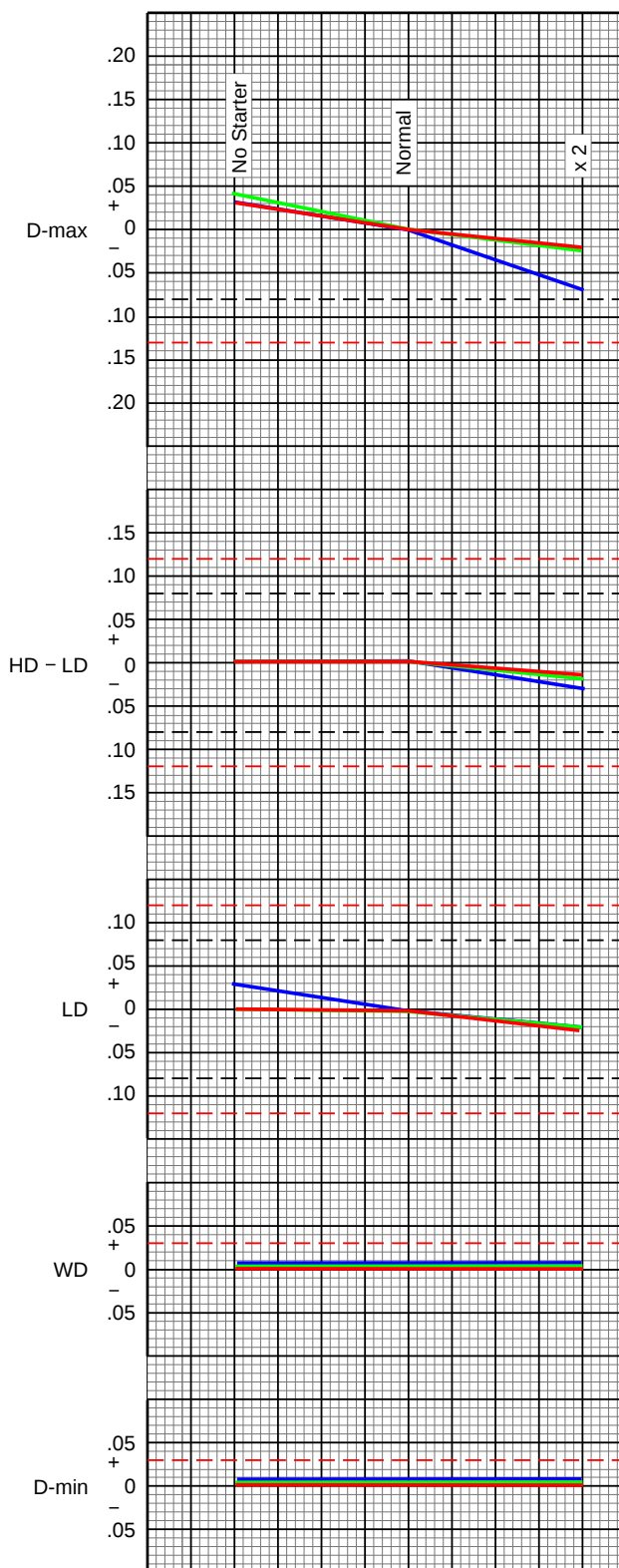
Mixing Error: Too Little/Too Much Starter Solution*

The amount of Color Developer II Starter affects the color-developer activity. Too little or no starter solution causes an increase of LD (blue). Too much starter solution causes, mainly, a decrease of D-max (blue). LD is affected only slightly.

Problem Correction

If too much starter was used, replace the color-developer mix with one that is correctly made. If too little starter is used and you know the amount that is missing, add the correct amount of starter. If you do not know the amount of starter necessary, make a new mix.

Chart 12



LOW LD

First Developer—Evaporation***

First-developer activity varies directly with its concentration. Evaporation of the first-developer tank solution, if not compensated for, leads to over concentration and increased activity. You will see this as a decrease in LD.

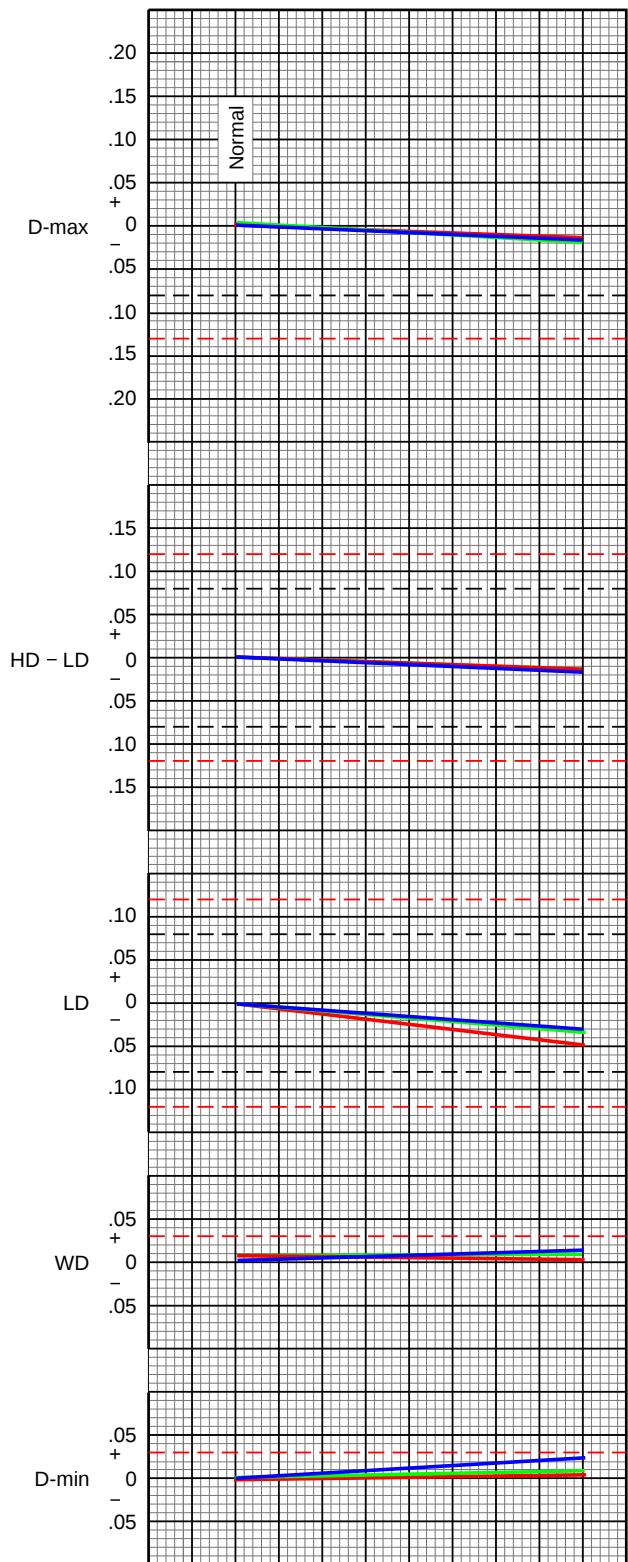
Problems occur most frequently in roller-transport processors which, because of their design, are particularly susceptible to solution evaporation.

In addition, these processors often have a low rate of utilization which can increase the rate of evaporation. See KODAK Publication No. Z-129B, *Using KODAK EKTACHROME R-3 Chemicals in Continuous and Roller-Transport Processors*, for low-utilization recommendations.

Problem Correction

Evaporation should be compensated for every morning by topping-up the level in the first-developer processor tank with water. When you notice an unusual amount of solution evaporation, first confirm that it is evaporation by measuring the solution specific gravity. If it is too high, readjust it by adding water in the processor tank. Usually, readjusting the solution specific gravity will be sufficient for recovering the correct first-developer activity. Check the area around the developer tank for high ventilation or low humidity. This promotes evaporation. Also see KODAK Publication No. Z-129A, *Using KODAK EKTACHROME R-3 and R-3000 Chemicals*, for tank-solution acceptable specific gravities.

Chart 13



LOW D-MAX, HD-LD, LD

First Developer—Contaminated with Bleach-Fix**

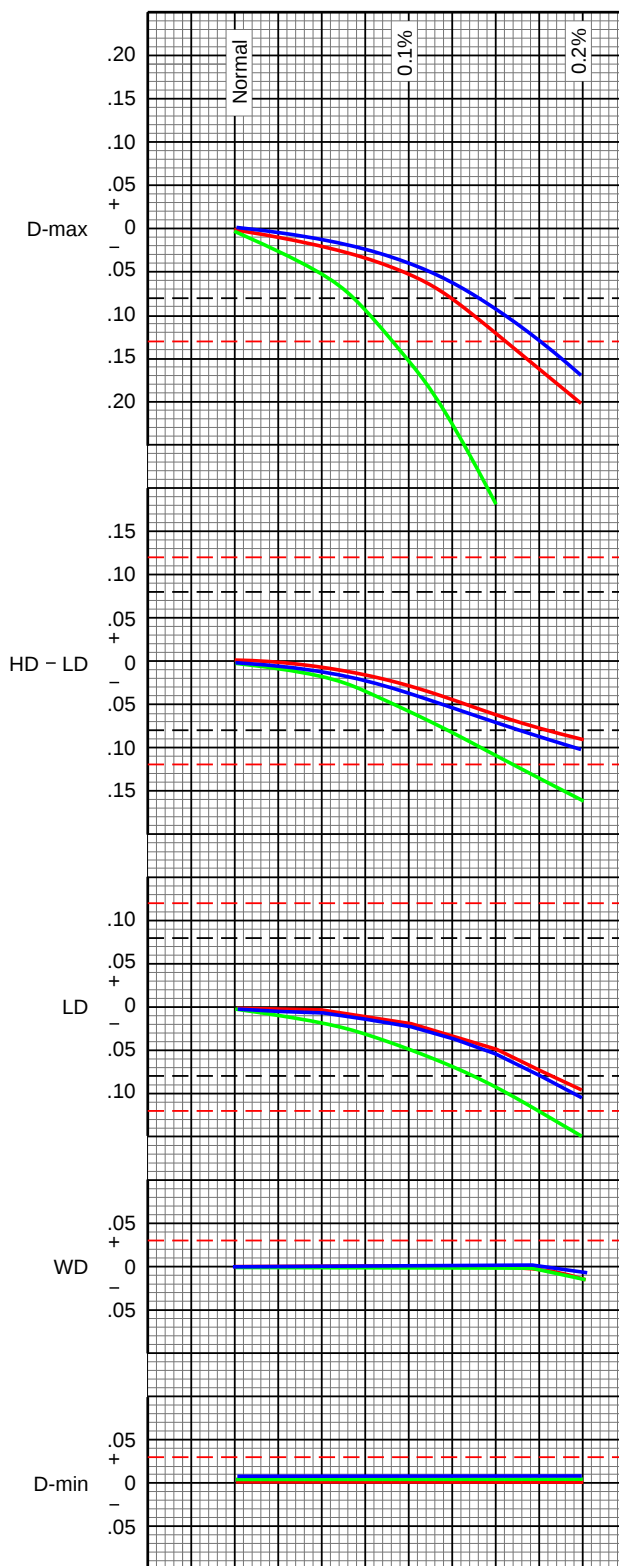
Trace amounts of bleach-fix (less than 0.5 mL of bleach-fix per litre of first developer) can seriously contaminate the first developer. In the control plots, you will see this as a severe decrease in green D-max, HD-LD, and LD.

Problem Correction

This type of contamination is serious and cannot be corrected. Replace the first-developer tank solution with a fresh mix. If the first-developer replenisher is contaminated, replace it also.

Always use separate mixing equipment for bleach-fixes and fixers. Do not mix bleach-fix solutions near the processor. Be careful not to splash bleach-fix into the developers when repairing paper-strand breaks or when raising racks.

Chart 14



LOW D-MAX, HD-LD, LD

Color Developer—Contaminated with Bleach-Fix**

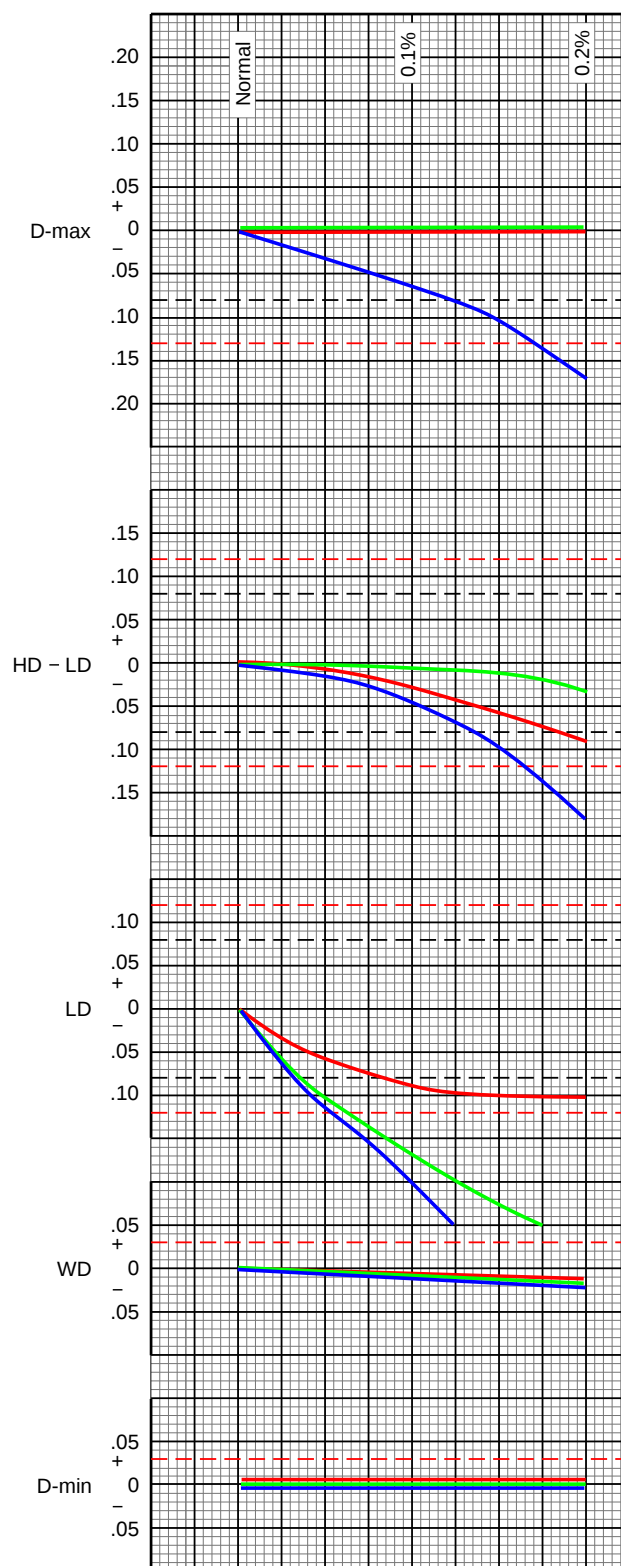
Trace amounts of bleach-fix (less than 0.5 mL of bleach-fix per litre of color developer) can seriously contaminate the color developer. In the control plots, you will see this as a severe decrease in blue D-max, HD-LD, and LD.

Problem Correction

This type of contamination is serious and cannot be corrected. Replace the color developer tank solution with a fresh mix. If the color-developer replenisher is contaminated, replace it also.

Always use separate mixing equipment for bleach-fixes and fixers. Do not mix bleach-fix solutions near the processor. Be careful not to splash bleach-fix into the developers when repairing paper-strand breaks or when raising racks.

Chart 15



LIGHT CONTROL STRIP LOW D-MAX, HD-LD, LD

Color Developer—Contaminated with First Developer**

Trace amounts of first developer (less than 0.5 mL of first developer per litre of color developer) can seriously contaminate the color developer. Larger amounts of first developer decrease the amount of color-developer activity. In the control plots, you will see this as a severe decrease in blue D-max, blue HD-LD, and LD.

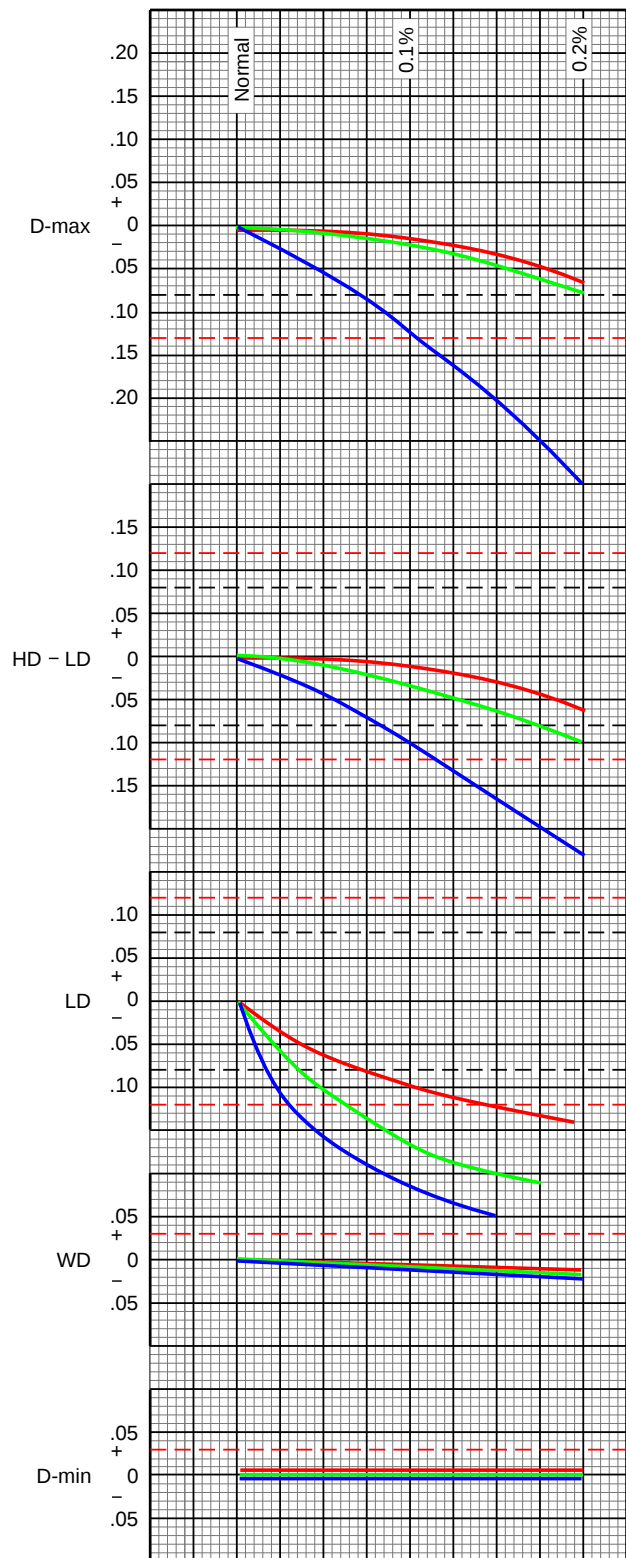
Problem Correction

This type of contamination is serious and cannot be corrected. Replace the color-developer tank solution with a fresh mix. If the color-developer replenisher is contaminated, replace it also.

If you use the same mixing equipment for the first developer and the color developer, be sure to wash the equipment and tanks thoroughly after each use. Sometimes first-developer replenisher is pumped into the color-developer replenisher storage tanks by mistake. To avoid that error, clearly label each tank and do not place the developer tanks too close together. Be sure that the first wash is adequate to avoid carry-over of residual amounts of first developer into the color developer.

IMPORTANT: If your processor is a leader-belt type, do not use polyamid (nylon) leaders; they will absorb first developer and carry it into the color developer. Use only polyester or polypropylene belts.

Chart 16



LOW D-MAX, HD-LD, LD, WD

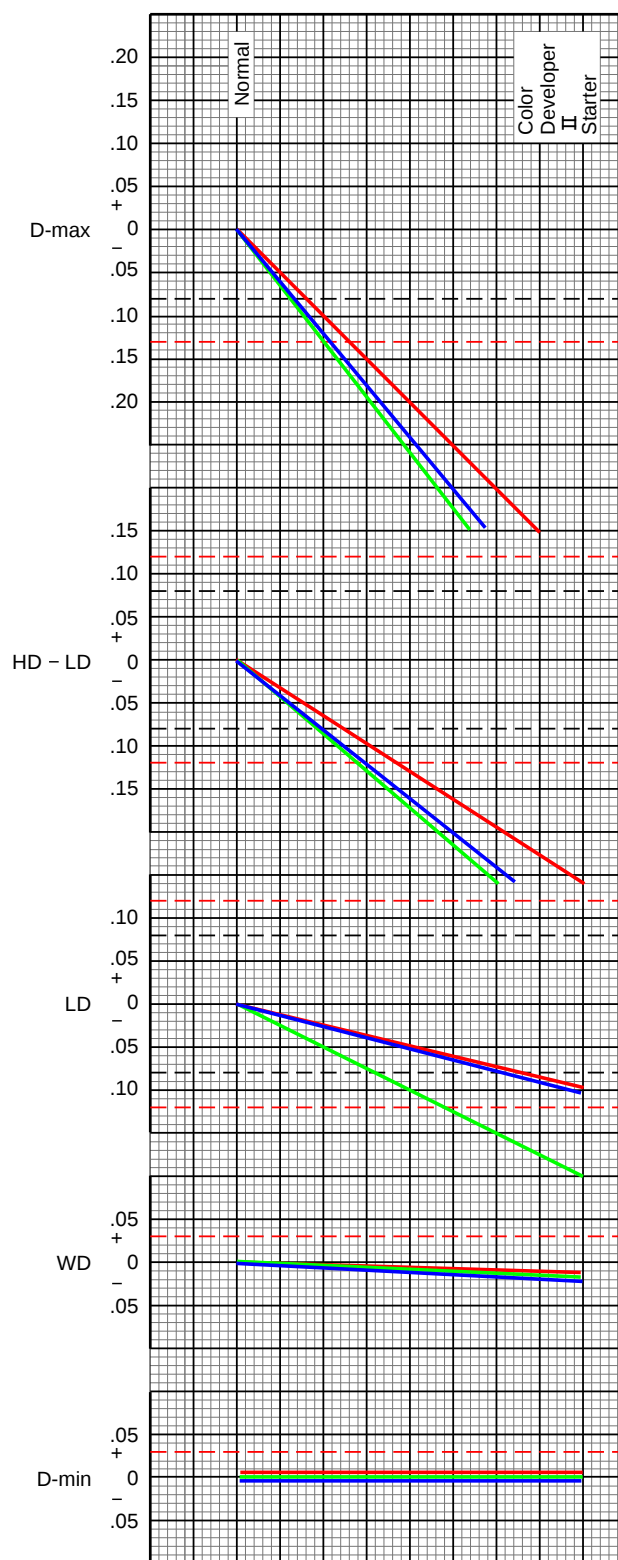
First Developer— Mixing Error: Wrong Starter**

It is important that the correct starter be used with the appropriate replenisher when making a fresh developer working tank solution. For making a fresh first-developer working tank solution, you must use First Developer II Starter. Using Color Developer II Starter will result in an over-active first-developer working tank solution. In the control plots, you will see this as a decrease in WD, LD, HD-LD, and D-max.

Problem Correction

If the wrong starter (Color Developer II Starter) was used, you can still use your fresh first-developer tank solution provided that you add the correct amount (5 mL starter/1L of tank solution) of First Developer II Starter.

Chart 17



LOW HD-LD, LOW LD

Color Developer Replenisher— Mixing Error: Too Little Part A* Mixing Error: Too Much Part A*

If too little Part A is used to mix the color developer replenisher, the mix will be unusable as either a tank or replenisher solution. If you use the incorrectly made replenisher to make a tank solution, the process will immediately go out of control. If you use it as replenisher, the process will gradually drift out of control.

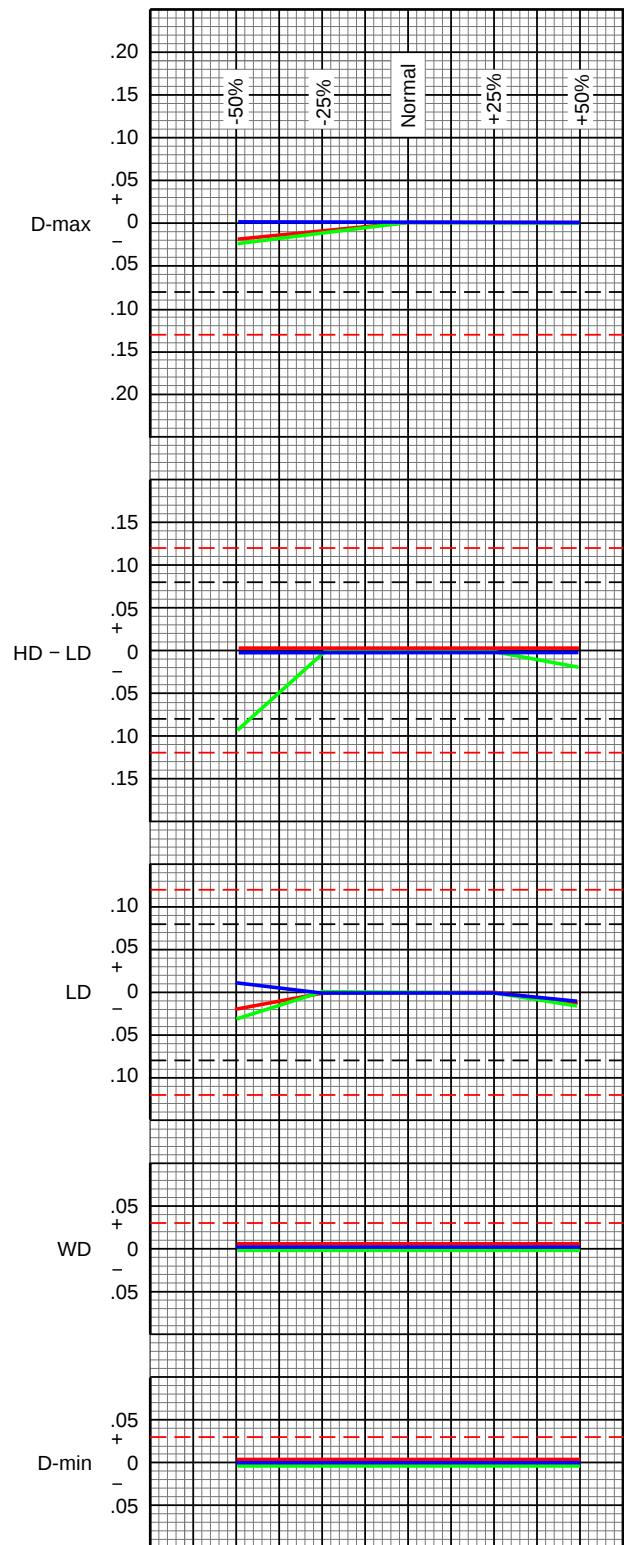
Too little Part A produces a decrease in green HD-LD and LD (red and green).

Too much Part A does not produce significant sensitometric shift. An incorrectly made replenisher containing too much Part A is usable provided the excess in Part A does not exceed 50%.

Problem Correction

It is difficult to correct gross mixing errors. Replace the color-developer replenisher with a correctly made mix. If the color-developer tank solution has been affected, replace it also.

Chart 18



LOW D-MAX, LOW HD-LD

Color Developer Replenisher— Mixing Error: Too Little Part B* Mixing Error: Too Much Part B*

If too little Part B is used to mix the color developer replenisher, the mix will be unusable as either a tank or replenisher solution. If you use the incorrectly made replenisher to make a tank solution, the process will immediately go out of control. If you use it as replenisher, the process will gradually drift out of control.

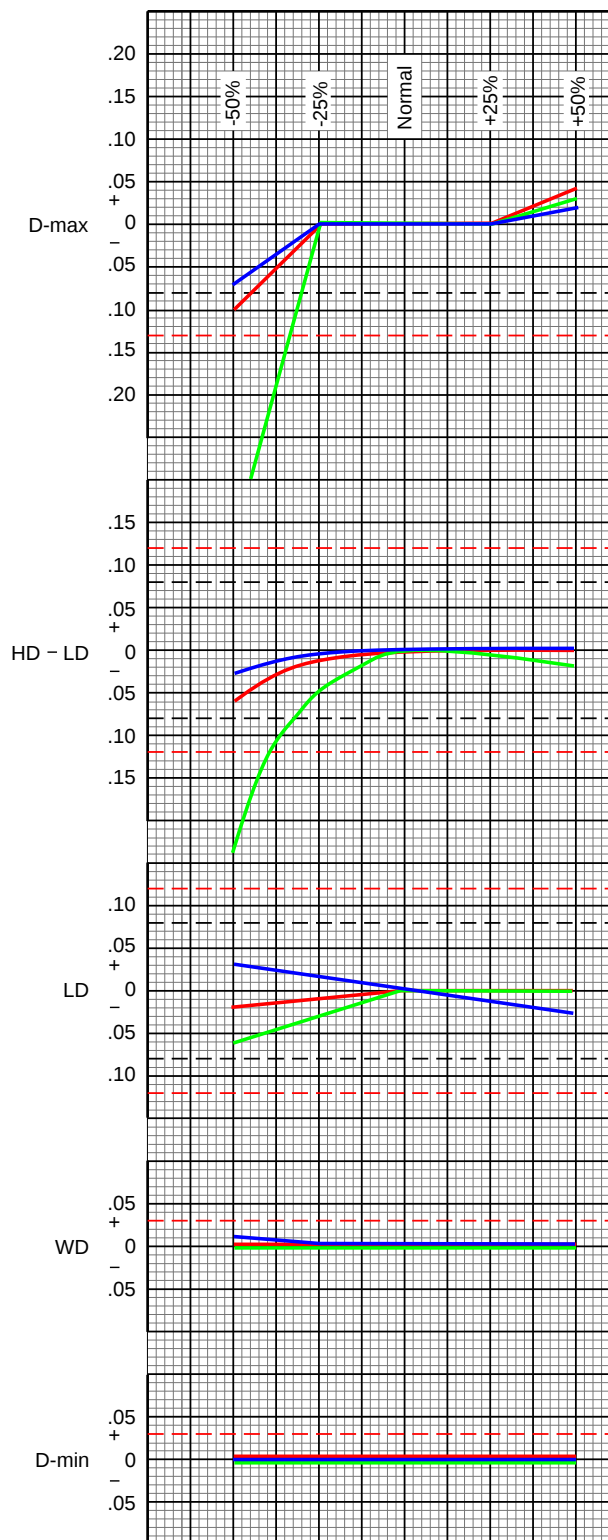
Too little Part B produces a decrease in D-max (especially green) and HD-LD (especially green). You also will notice a change in LD (high LD blue and low LD green).

Too much Part B does not produce significant sensitometric shift. An incorrectly made replenisher containing too much Part B is usable provided the excess in Part B does not exceed 50%.

Problem Correction

It is difficult to correct gross mixing errors. Replace the color-developer replenisher with a correctly made mix. If the color-developer tank solution has been affected, replace it also.

Chart 19



LOW D-MAX, LOW HD-LD, LD

Color Developer Replenisher— Mixing Error: Too Little Part C* Mixing Error: Too Much Part C*

If too little Part C is used to mix the color developer replenisher, the mix will be unusable as either a tank or replenisher solution. If you use the incorrectly made replenisher to make a tank solution, the process will immediately go out of control. If you use it as replenisher, the process will gradually drift out of control.

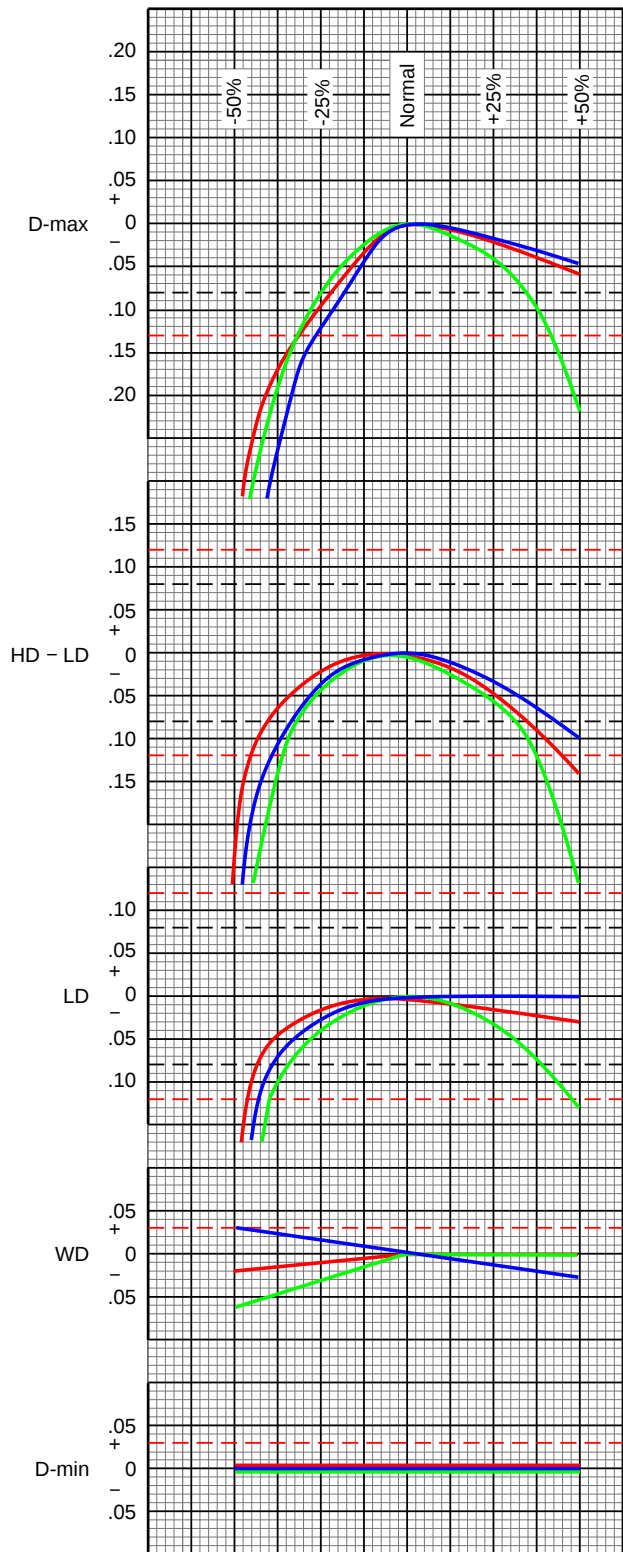
Too little Part C produces a decrease in D-max, HD-LD, LD, and WD.

Too much Part C also produces a decrease in D-max, HD-LD, LD (especially green). You may notice also an increase of WD.

Problem Correction

It is difficult to correct gross mixing errors. Replace the color-developer replenisher with a correctly made mix. If the color-developer tank solution has been affected, replace it also.

Chart 20



LOW D-MAX, LOW LD

First Wash—Low Flow Rate***

First Wash—Short Time***

First Wash—No Countercurrent Tanks***

The first wash removes first developer. Inadequate washing allows any first developer remaining in the paper or material to continue the development reaction. Inadequate washing can be caused by a low water flow rate, short wash time, or lack of a countercurrent wash-tank arrangement. An inadequate first wash can also result in contamination of the color developer by residual first developer. (See Chart 16.)

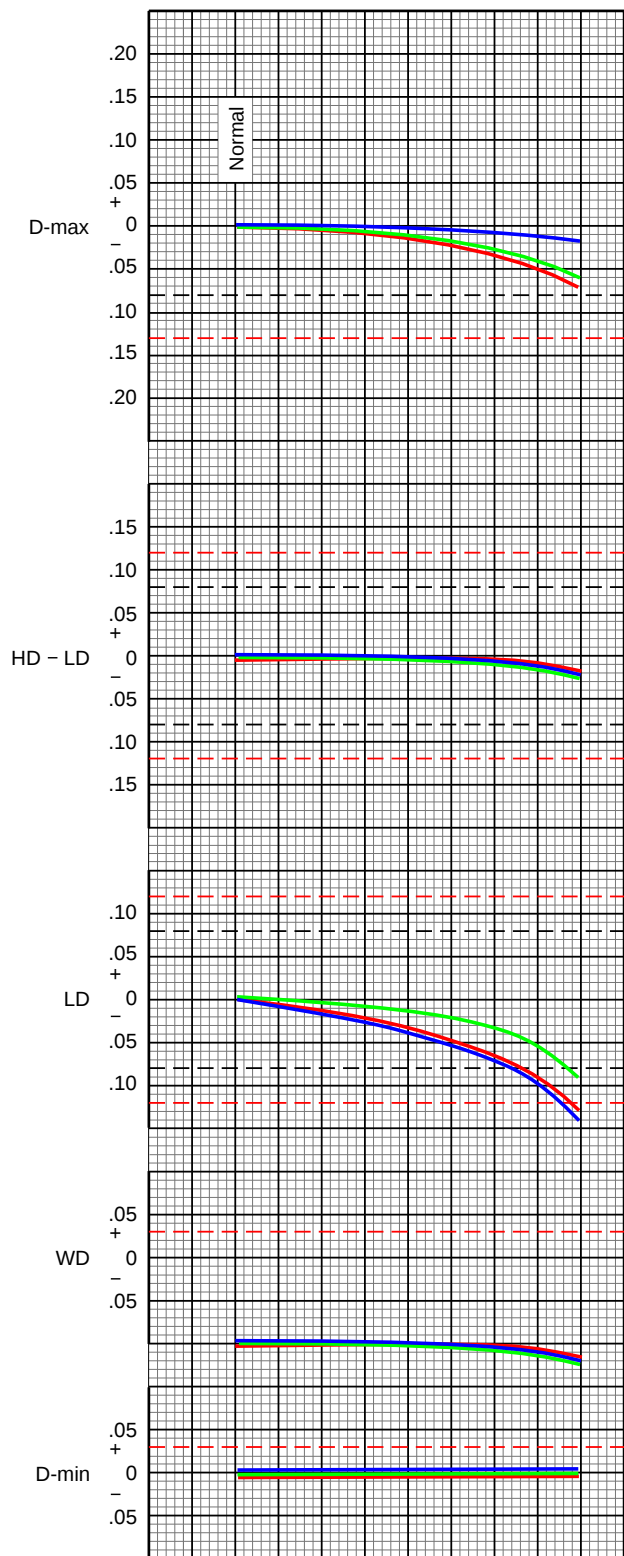
In the control plots, an inadequate first wash will cause a decrease in LD and D-max.

Problem Correction

Check the wash time. It should not be less than 90 seconds. Check the water flow rate to the first wash. The recommended minimum wash rate is 5 L/m^2 (460 mL/ft^2). (In no case should the wash rate be less than 2 litres per minute.)

If your processor does not have two countercurrent tanks for the first wash, the effect will be the same as a short wash time. In this case the flow rate must be increased from 5 L/m^2 (460 mL/ft^2) to 25 L/m^2 (2.3 L/ft^2).

Chart 21



LOW D-MAX, HD-LD, LD

Color Developer—Replenishment Rate**

Color-developer activity varies with the replenishment rate. An incorrect replenishment rate will not cause an immediate change, but its effect will appear over a period of time. How quickly the change occurs depends on the processor tank volume, machine speed and amount of paper or material processed.

A low color-developer replenishment rate causes a decrease in color-developer activity. The replenishment rate is critical at the lower limit—not less than 330 mL/m² (30.6 mL/ft²) or 500 mL/m² (4.6 mL/ft²) for leader-belt processors. In the control plots, underreplenishment will cause a D-max loss (especially blue) and a decrease in LD.

A higher than recommended color-developer replenishment rate is not harmful. It is simply a waste of solution.

Problem Correction

If you suspect that replenishment is the problem:

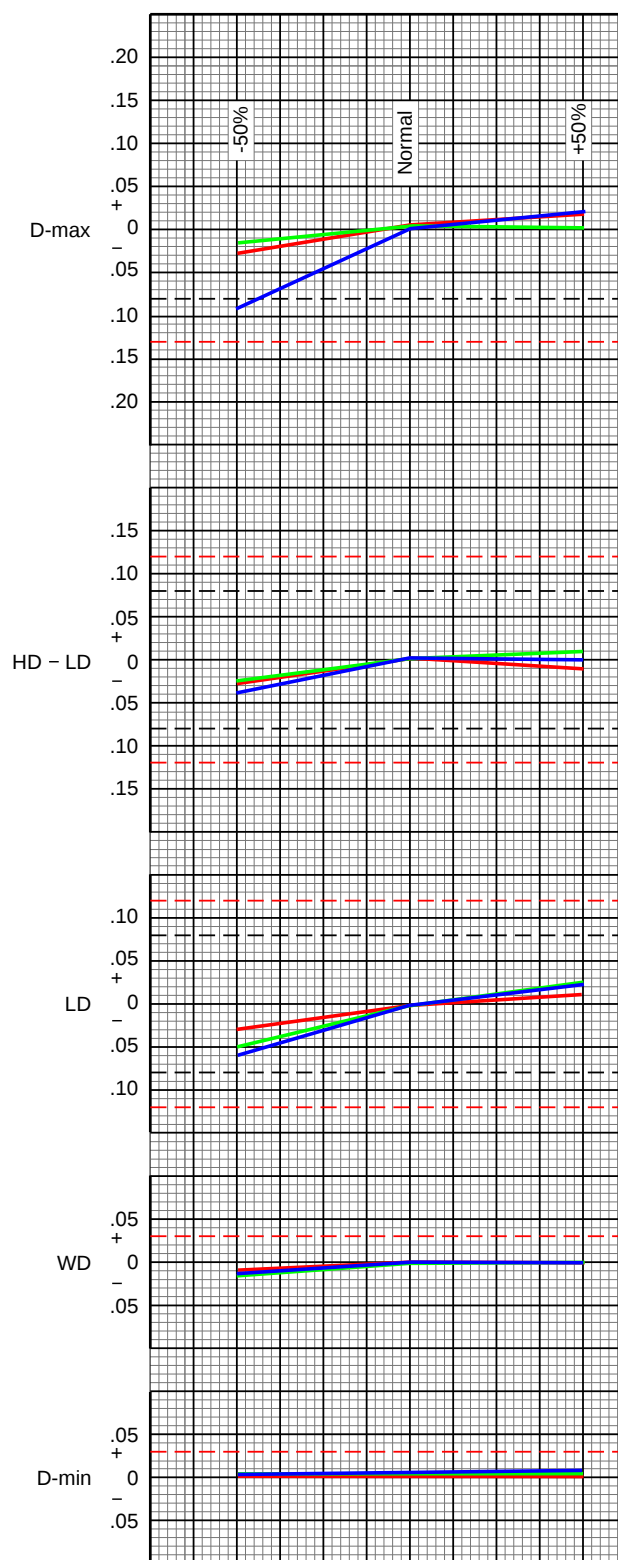
1. Check that the replenishment rate is set correctly.
2. If you set your replenishment rate for the average paper width being processed, are your calculations correct?
Does paper width vary seasonally? Use this calculation to check your replenishment rate.

Flow Rate	=	Processor Speed	x	Paper Width	x	Replenishment Rate
mL/min		(ft or m/min)		(ft or m)		(mL/ft ² or m ²)

3. Was paper processed without replenishment? Check.
4. Check for mechanical problems in the replenishment system. Is the system replenishing at a constant rate?
5. Check the metering pump to see if it is operating properly and is correctly calibrated.

Depending on the severity of the problem: You can wait and tolerate the problem, allowing the correction you have made to take effect; you can replace some of the color-developer tank solution; or you can replace the entire color-developer tank solution.

Chart 22



LOW D-MAX, HD-LD, LD

Color Developer—Dilution Mixing Error** First Wash—Ineffective Squeegees at Wash Exit***

Dilution of the color developer will lower its activity. Over-diluted color developer may be caused by mixing errors. This can occur if you simply add an incorrect amount of water or use an incorrectly calibrated mix tank. Dilution may also result from a poor squeegeeing at the first-wash exit that allows an excessive water carry-over.

You can use specific-gravity measurements to verify the color-developer concentration (KODAK Publication No. Z-129A, KODAK EKTACHROME R-3 and R-3000 Chemicals).

An over-dilute color-developer replenisher or an inefficient squeegee will not cause an immediate change, but their effects will appear over a period of time. How quickly the change occurs depends on the processor tank volume, the machine speed, and the amount of paper or material processed.

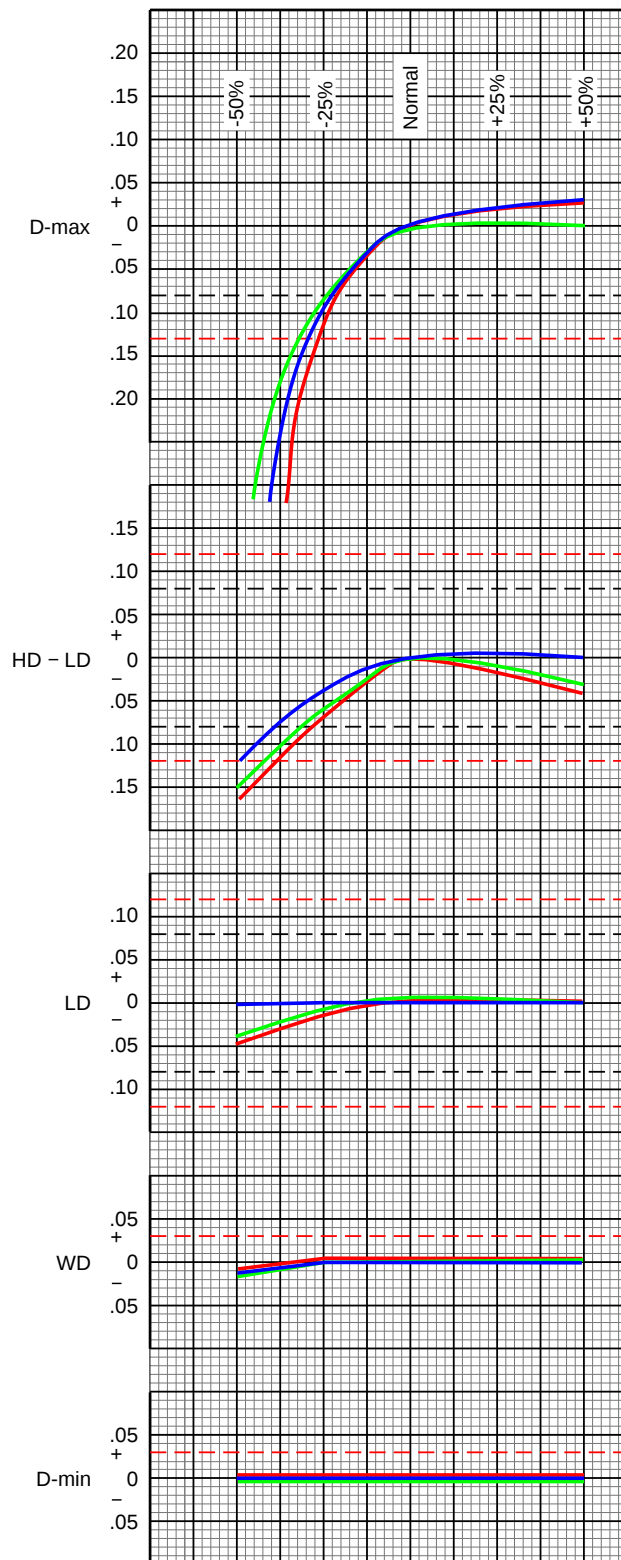
In the control plots, dilution will cause a D-max loss and a decrease in HD-LD and LD (especially red and green).

A too concentrated color-developer is not harmful. It is simply a waste of solution.

Problem Correction

Check your mixing procedures. Was the amount of water measured incorrectly? Check the calibration of your mixing tanks. Depending on the severity of the problem, you can wait and tolerate the problem, allowing the correction you have made to take effect; you can replace some of the color-developer tank solution; or you can replace the entire color-developer tank solution.

Chart 23



LOW D-MAX, HD-LD, LD

Color Developer—Low Temperature***

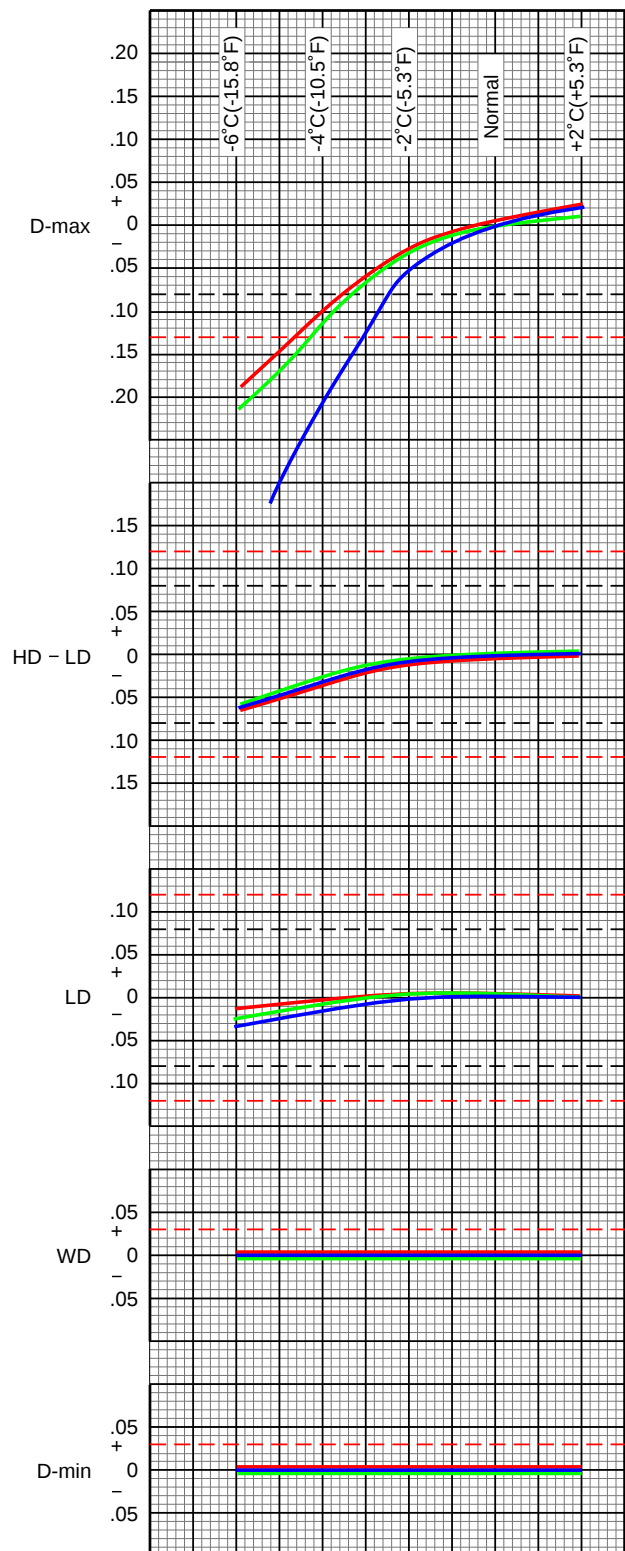
The color-developer activity varies directly with temperature. A color-developer temperature that is too low causes a decrease in color-developer activity, and allows less dye to be formed. In the control plots, you will see this as a decrease in D-max (especially blue) and HD-LD.

A higher color-developer temperature is not critical in terms of photographic results but may increase evaporation and oxidation, especially in roller-transport processors.

Problem Correction

With an accurate, calibrated thermometer, check the color-developer temperature at start-up and at several times when the processor is operating. The temperature must be within $\pm 1^{\circ}\text{C}$ ($\pm 2^{\circ}\text{F}$) of your standard. At start-up, turn on the pumps far enough in advance of processing to allow the solutions to reach the normal temperature. Be sure that the recirculation pump is operating properly. Out-of-control problems that are caused by temperature fluctuations are often difficult to diagnose. Problems caused by electrical or equipment malfunctions can appear and disappear rapidly.

Chart 24



LOW D-MAX, HD-LD

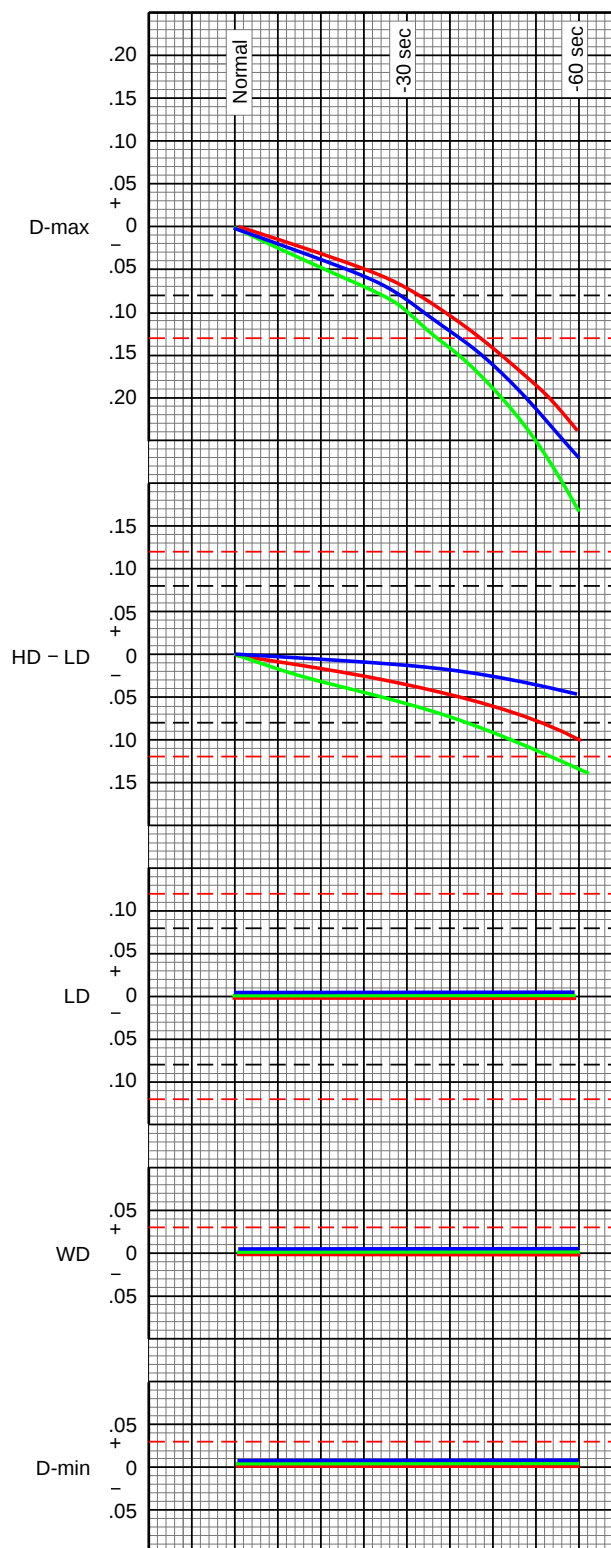
Color Developer—Short Time*

Color-developer activity varies directly with time. The color-developer time must not be less than 2 minutes, 15 seconds. Insufficient time lowers color-developer activity, and less dye will be formed. In control plots, you see a severe loss in D-max (especially green) and HD-LD (especially green). Longer color-developer times are generally not a problem.

Problem Correction

Time variations are unlikely in continuous processors because processor speed is determined by a motor drive. Be sure that all racks are in their correct positions, especially if the processor has been cleaned or rethreaded.

Chart 25



LOW D-MAX

Second Wash—Low Temperature*

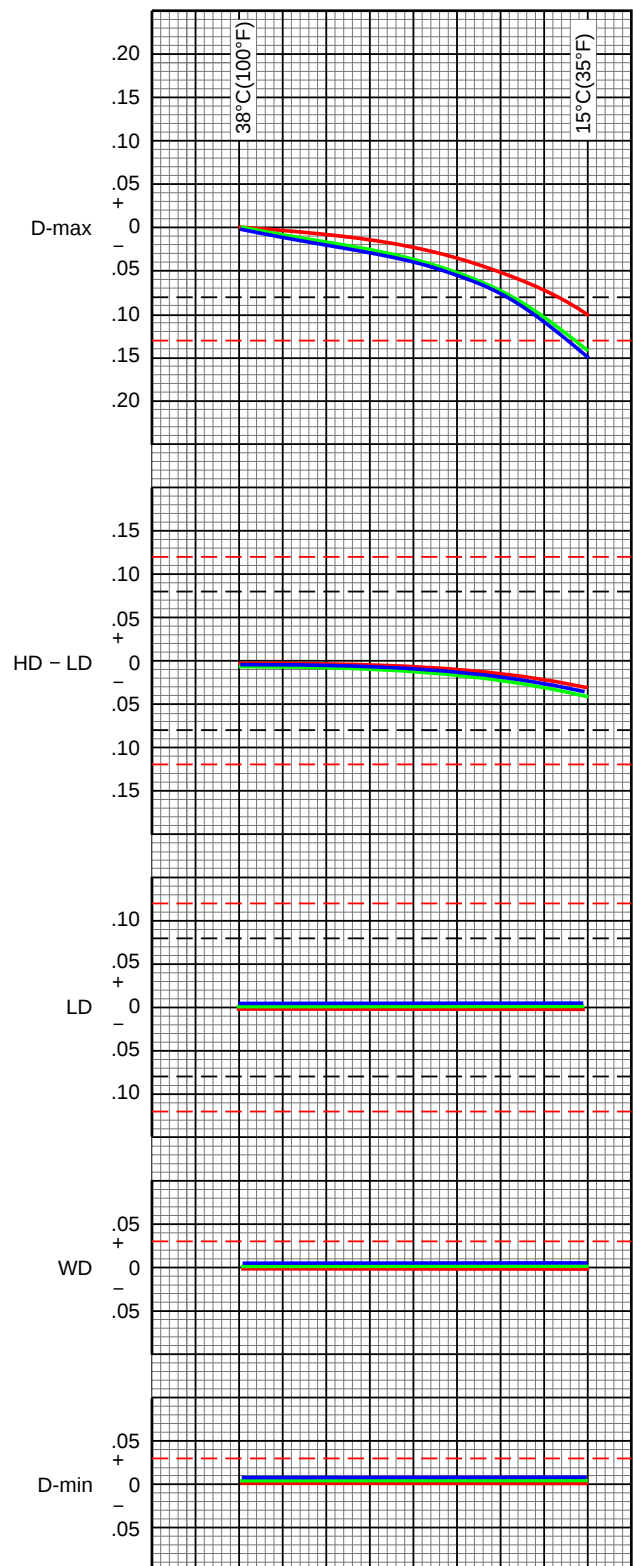
Although the second wash removes color developer from the paper, development activity continues for a short time in the second wash. If the temperature of the second wash is too low, this extra development is reduced and less dye is formed. This shows as a decrease in D-max.

Besides a low temperature water supply, you also may have too low a temperature in the second wash when the processor is not used for a long period of time during the day.

Problem Correction

If the temperature is less than 27°C (81°F), increase the incoming water temperature.

Chart 26



LOW D-MAX, HIGH LD, WD, D-MIN

Second Wash—No Second Wash*

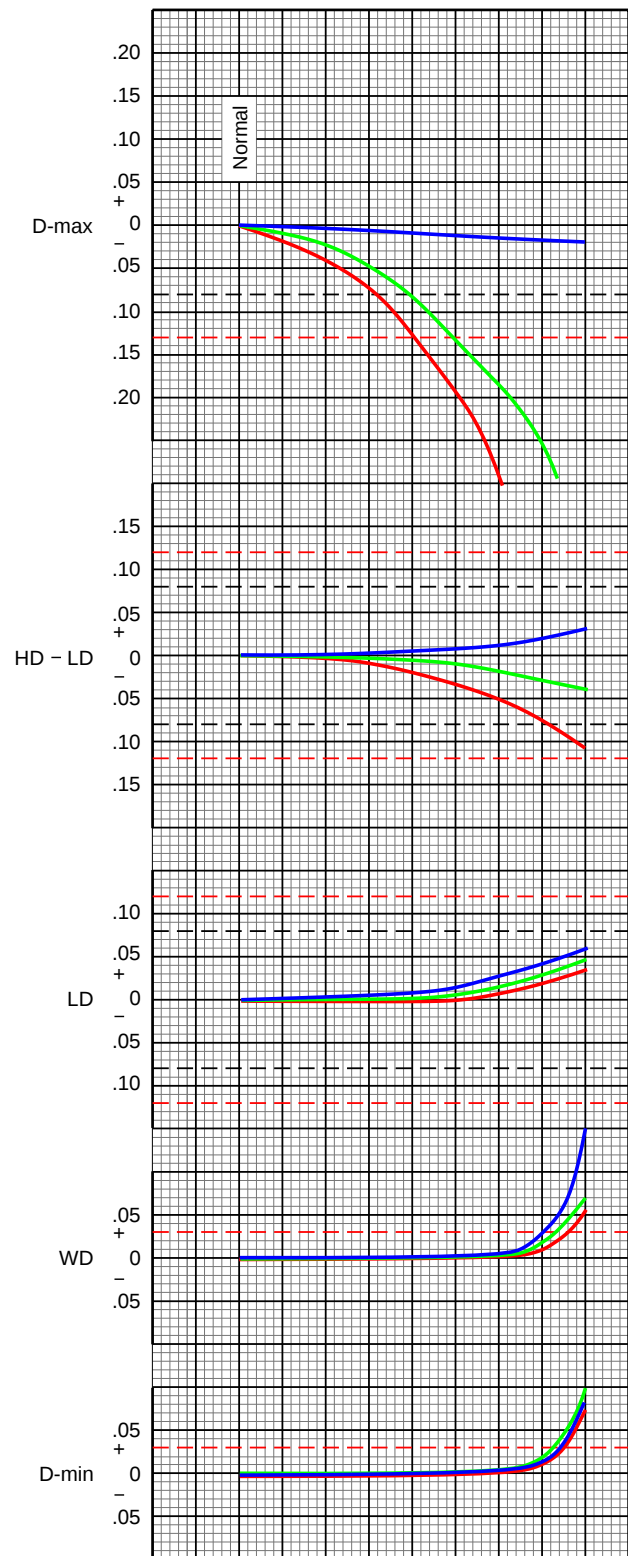
The second wash removes residual color developer from the emulsion before it enters the bleach-fix. This is necessary to maintain the pH of the bleach-fix. A large increase in the bleach-fix pH (greater than 7.5) will decrease bleach-fix activity, and leuco cyan dye may form. Time and flow rate of the second wash are not extremely critical. A more serious situation occurs when the second wash is omitted.

In the control plots, you will first notice the effect of no second wash as a large decrease in D-max and HD-LD. This is especially true of the red D-max because of leuco-cyan dye formation. Very strong contamination of the bleach-fix by carried over color developer may also result in silver retention. You will see this in the D-min and WD.

Problem Correction

Make sure the drain valve on the second wash is closed. If you do not have a second wash, make provisions for one. The second wash must use a flow rate of 1000 mL/m² (93 mL/ft²). If leuco cyan dye forms and silver retention increases, you can correct the problem by rebleaching the paper or material in a fresh solution of ferricyanide bleach made up of 37.5 grams of potassium ferricyanide and water to make 500 mL.

Chart 27



LOW D-MAX, HD-LD, LD

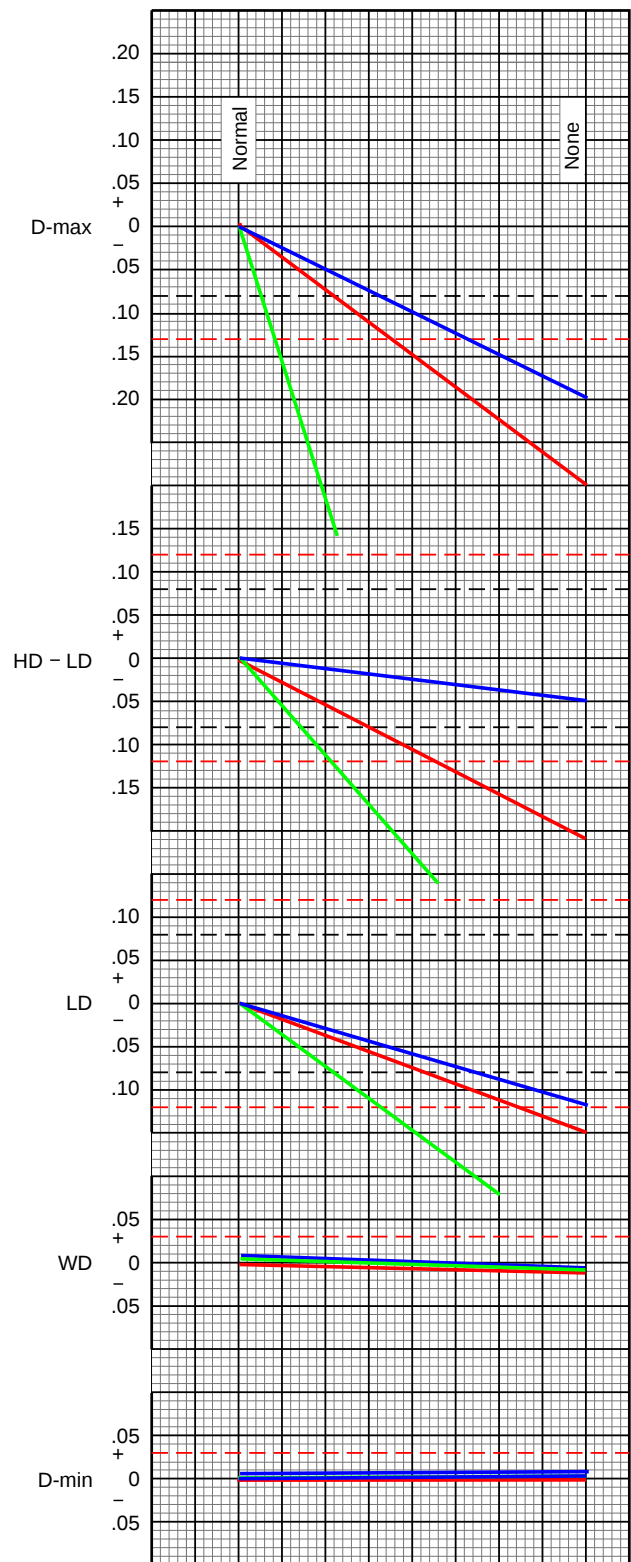
Reversal Light—Reversal Light Out**

Reversal exposure is necessary after the first wash or at the beginning of the color developer. The reversal light must supply a minimum of 100 lux (9.3 foot-candles) for 5 to 10 seconds. If the reversal light is out or reversal exposure is inadequate, you will see a severe loss in D-max, HD-LD, and LD (especially green).

Problem Correction

First, confirm that it is a problem related to reexposure: Pick up a control strip at the exit of the first wash, reexpose it in room light, and reintroduce it into the processor before the color-developer processing step. If D-max is correct, then check that the lamp in the processor is operating. If it is, check its intensity. Check that the glass protecting the light source is clean, especially if the lamp is located at the bottom of the first wash tank.

Chart 28



FOR HIGH-QUALITY PRINTS, MONITOR YOUR PROCESS CAREFULLY AND CONSISTENTLY

The information in this publication will help you to monitor your process. You'll minimize any problems by carefully following the instructions for mixing your chemicals, by using the correct processing conditions for your processor, and by properly maintaining your equipment. When problems occur, check your control charts and refer to this publication for assistance. Of course, if you find you can't solve a problem and need assistance, Kodak's field representatives are ready to help. These "tools" provide you with the means to produce high-quality prints for the type of customer satisfaction that means good business.

MORE INFORMATION

Kodak has many publications to assist you with information on Kodak products, equipment, and materials.

Complete information on KODAK EKTACHROME RADIANCE III Paper and Select Material is available on the Kodak website **www.kodak.com/go/professional** and through Kodak in your country.

