

# 7 Process Monitoring and Troubleshooting with KODAK Control Strips, Process RA-4

To produce high-quality color prints consistently and with a minimum of waste, you need to match your process to a standard for density, color, and contrast each time you process paper. In addition to monitoring process parameters such as solution times, temperature, replenishment rates, solution concentrations, etc., you should regularly run control strips to ensure best results.

Kodak recently improved KODAK Control Strips, Process RA-4, for monitoring Process RA-4 in photofinishing labs. These strips are designed for use with KODAK EKTACOLOR Edge 8 Paper and EKTACOLOR ROYAL VIII Paper. KODAK Control Strips, Process RA-4, will detect process conditions that can degrade the quality of your finished prints.

**Note:** Kodak has also introduced new control strips that are designed for use with KODAK PROFESSIONAL Papers and KODAK PROFESSIONAL Print and Display Materials. KODAK PROFESSIONAL Pro Strips Color Negative Paper Control Strips / for Process RA-4 (CAT No. 129 8587) are better able to track the papers and the materials that are processed in professional finishing laboratories. Recommendations for using KODAK PROFESSIONAL Pro Strips are available in Section 8, *Process Monitoring and Troubleshooting with KODAK PROFESSIONAL Pro Strips Color Negative Paper Control Strips / for Process RA-4*.

This section describes standards and methods for setting up your process and for ongoing process monitoring. The primary “tools” for monitoring your process are the control strips and the reference strip. This section also describes how to use control strips and interpret the results. For the most up-to-date information, you can check the Kodak website, [www.kodak.com/go/photochemicals](http://www.kodak.com/go/photochemicals).

## Using KODAK Control Strips, Process RA-4, with KODAK EKTACOLOR Edge 8 Paper

Beginning with control-strip code 0001, KODAK Control Strips, Process RA-4, will be made from KODAK EKTACOLOR Edge 8 Paper. The improved design of the paper will make it easier to maintain good process control and print quality. Because KODAK EKTACOLOR Edge 8 Paper is relatively insensitive to the formation of leuco-cyan dye, you will no longer need to consider leuco-cyan dye as a process problem. If your lab is processing KODAK PROFESSIONAL Papers and KODAK PROFESSIONAL Print and Display Materials, you should consider converting to KODAK PROFESSIONAL Pro Strips so that you can monitor those materials for leuco-cyan dye.

KODAK EKTACOLOR Edge 8 Paper is designed so that a visually neutral patch, e.g., the LD patch on the control

strip, will have approximately balanced red, green, and blue densities when measured with densitometers that conform to ANSI Status A responses. Some densitometers that do not conform to ANSI Status A responses may yield non-matched red, green, and blue density readings for a visually neutral patch on these papers. For example, the LD patch of control strips manufactured from EKTACOLOR Edge 7 Paper and EKTACOLOR Edge 8 Paper may both measure 0.80 red, 0.80 green, and 0.80 blue on a densitometer that complies with ANSI Status A responses. However, if a lab uses a non-Status A densitometer, the LD patch on EKTACOLOR Edge 7 Paper will measure 0.80 red, 0.80 green, and 0.80 blue while the LD patch on EKTACOLOR Edge 8 Paper measures 0.65 red, 0.80 green, and 0.80 blue. This will not cause problems with print quality, because each control strip is compared with a reference strip to determine the control values, and any bias from the densitometer will be cancelled out.

For more information, visit our website at [www.kodak.com/go/colorpapers](http://www.kodak.com/go/colorpapers).

## PROCESS-MONITORING TERMS

The following terms are commonly used in process monitoring:

**Action Limits**—The action limits are the boundaries of the aim operating range of the process. As long as the control-strip 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 process customer work, but you should check for the cause of the shift and correct it. When the density values plot between the upper and lower action limits (i.e., the “aim zone”), your process is in control.

**Aim Values**—You compare your control-strip density readings to these values. To obtain aim values, read the reference-strip densities; then apply the correction factors (supplied with the control strips and reference strip) to those density readings. Enter the aim values in the spaces provided on the left side of your control chart.

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

**Control Strips**—These are precisely exposed strips used to monitor your process.

**Correction Factors**—Use these numbers to adjust the densities of the reference strip to obtain aim values. They are printed in the instruction sheet packaged with each box of control strips. Correction factors usually differ for each batch (code number) of control strips.

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

**Tolerances and Limits**—Tolerances and limits are density variations allowed before you must take corrective action. They include an aim-value adjustment tolerance, and action and control limits. The tolerances and limits for KODAK Control Strips, Process RA-4, are listed in Table 7-1.

**Table 7-1**  
**Tolerances and Limits for KODAK Control Strips, Process RA-4**

Measurement	Aim-Value Adjustment Tolerance	Action Limits	Control Limits
D-min	—	—	+ 0.02
LD	± 0.04	± 0.07	± 0.10
HD – LD	± 0.03	± 0.07	± 0.10
BP	± 0.05	- 0.10	- 0.15

## KODAK CONTROL STRIPS, PROCESS RA-4

### The Basic Control Material

These strips are available in boxes of ten moisture-resistant envelopes that contain five strips each. 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 correction factors to calculate the aim values for each batch of strips.

Each strip measures 3½ x 12 inches, and contains three neutral patches, a yellow patch, and an unexposed area. Measure the neutral patches to obtain density values for LD (low density), HD (high density), and BP (black patch). Measure the unexposed patch to obtain the density value for D-min. Use the yellow patch as a visual indicator of retained silver caused by low bleach-fix activity. Low bleach-fix activity will make the yellow patch appear brown and less saturated than normal.

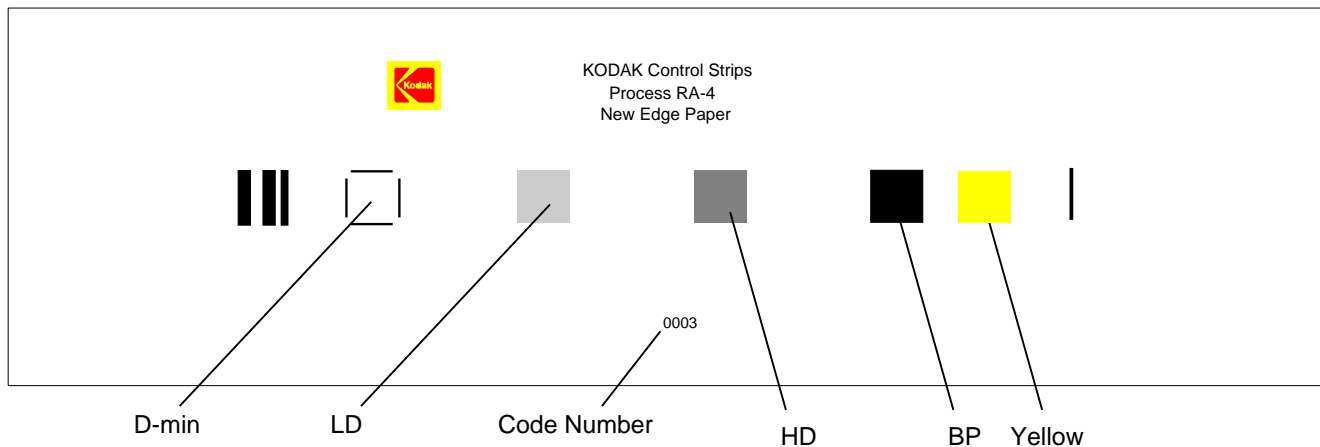
### Storing and Handling Control Strips

Store unused control strips at -18°C (0°F) or lower. Handle unprocessed strips in total darkness. Remove only a day's supply from one package at a time; then reseal and return the package to the freezer as quickly as possible. **Do not** keep the package out of the freezer for more than one hour per day.

Store your daily supply of control strips in a lighttight container at room temperature. Be sure to allow the strips to reach room temperature before you process them. Handle control strips by the edges to prevent fingerprints and surface damage.

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

Figure 7-1



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## Starting Out

To begin process monitoring, you will need—

- KODAK Control Strips, Process RA-4
- An electronic densitometer equipped with Status A filters
- KODAK Process Record Form, KODAK Publication No. Y-55, or similar graph paper
- Red, green, and blue pencils

You can also plot your process by following the procedure in the KODATEL Quality Management System.

## Processing Control Strips

Each time you process a control strip, position it in the same location in your processor. Follow this schedule for processing 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

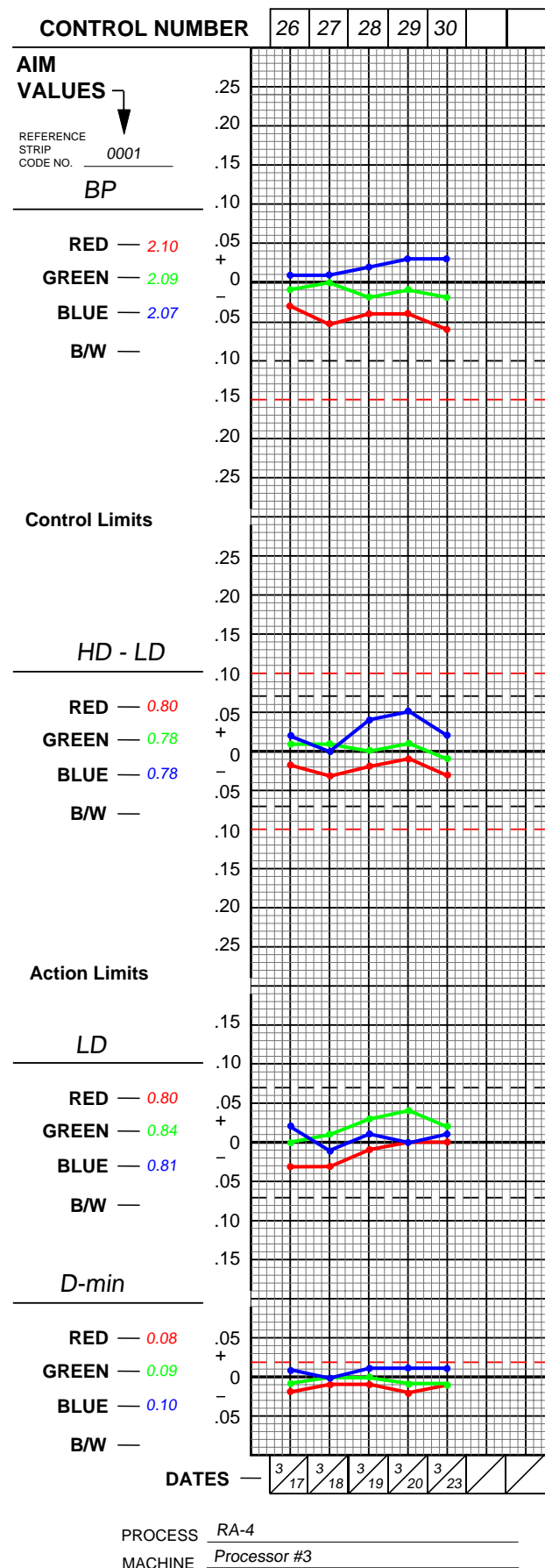
Create a control chart by using the KODAK Process Record Form Y-55 or similar graph paper (see the example in Figure 7-2). Then follow the procedure below:

1. Draw in the action and control limits given in Table 7-1. Use black for the action limits and red for the control limits.
2. Remove the reference strip from the box of control strips.

**IMPORTANT:** Allow the reference strip to warm up to room temperature before you remove it from its envelope (about 15 minutes). Exposing a frozen 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.

3. Use a precision electronic densitometer to measure the Status A red, green, and blue densities in the center of the D-min, LD, HD, and BP patches of the reference strip. **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, the reference strip, and the control strips identifies each batch.

Figure 7-2



4. To calculate aim values, apply the correction factors supplied in the instruction sheet packaged with the 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.

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 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 *DIAGNOSTIC CHARTS* and the *CONTROL-CHART EXAMPLES* will help you troubleshoot process problems.
8. Whenever you take corrective action, process another control strip to confirm that the process is in 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 batches (code numbers) will 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 under *Processing Control Strips*.
4. For your current batch of control strips, calculate the variations from aim by subtracting your current aim densities from the densities of the three strips. Plot the variations on your control chart.
5. For the new batch of strips, calculate the variations from aim by subtracting the new aim densities (calculated in step 3) from the densities of the three strips. Plot the variations on your control chart.
6. Calculate the differences between the variations from aim of the current strips and the new strips. Average these differences; then divide the result by 2.
7. Add or subtract the results from step 6 from the aim values for the new batch of strips determined in step 3. The amount of the adjustment should not exceed the aim-value adjustment tolerances given in Table 7-1. 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 batch of strips.

## INTERPRETING YOUR CONTROL PLOT

Your control plot provides a running record of your process. It will show how consistent your process is, and how well it meets your aim. It provides you with helpful information for analyzing and correcting process problems. Your process will produce acceptable results if your control strips plot within the control limits.

### Corrective Action

When one or more process parameters exceed the control limits, stop processing customer work until you find the cause of the problem and correct it. 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, low activity, and high D-min. Also, you can check your control chart to determine if the process drifted out of control slowly or changed suddenly.

#### 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)
- Mixing error
- 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)
- Mixing error
- Developer tank solution diluted with water
- Developer contamination

#### High D-min

This condition can be caused by—

- Developer oxidation resulting from low utilization
- Developer contamination
- Weak or oxidized, sulfurized bleach-fix
- Dirty stabilizer, or heavy dirt build up on wash racks/rollers

#### Trend

A trend shows an out-of-control condition that has occurred slowly over time. It indicates a problem such as—

**Improper replenishment**—Check that the replenishment rate is correct and that the replenishment system is operating properly. Also check for improperly mixed replenisher.

**Evaporation or oxidation**—Check for low utilization or air drawn into the processing solutions by a bad pump, a recirculation system leak, or a poorly placed ventilation fan.

**Contamination**—Check for photographically active materials that are leaching slowly into the solutions. The contaminants may come from anything that is in contact with the solutions, such as filters, plumbing, etc.

**Incorrect mixing**—Check for mixing errors caused by improper measurement, improper calibration of mixing tanks, etc. If you suspect that the problem was caused by incorrectly mixed replenisher solution, mix a new batch of replenisher to see if a fresh mix gradually corrects the problem.

#### Sudden Change

This is an out-of-control condition that occurs *suddenly*. It *usually* indicates a problem with—

**Control strips**—Check that you used control strips of the same code number. Remember, if you change code numbers, you need to establish new aim values for the new batch (see *Changing to a New Batch of Control Strips*). Check that the control-strip code numbers match those of the reference strip. Check that the strips were handled and stored properly.

**Densitometer**—If your densitometer is not working properly or is out of calibration, the density readings will be wrong. This can falsely signal a process change. Check that you used Status A filters.

**Time or temperature**—Check that the time and temperature are set correctly, particularly if they are easy to change accidentally.

**Contamination**—Bleach-fix splashed into the developer during rack cleaning or clearing a paper jam can cause sudden large spreads in your control plots.

**Solution mixing**—If the sudden change occurs after you have mixed a fresh tank solution, check that it was mixed correctly.

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

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

## How Each Processing Solution Affects Your Results

Each solution in Process RA-4 has a specific function. Operational errors involving each solution will affect process performance differently. When you understand the reaction of each solution, you can better diagnose processing problems.

### Developer

The developer chemically reduces the exposed silver halide in the paper to form a metallic silver image. At the same time, the color developing agent oxidizes and combines with dye couplers near the silver image to form a color image in each of the dye-forming emulsion layers. Once the dye image has formed, there is no need for the silver image. It will be removed by bleaching and fixing.

The amount of cyan, magenta, and yellow dye formed depends on exposure and developer activity. Temperature, time, replenishment rate, replenisher concentration, 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-Fix

The 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 of the control strip and a desaturation of the yellow patch on the control strip. Retained silver degrades image quality by desaturating the colors and is especially apparent when the yellow patch appears brown. It has a greater effect on higher-density areas, which contain more metallic silver. You can remove retained silver by reprocessing the paper or material in a good bleach-fix.

### Wash

Washing removes residual chemicals from the paper. If the chemicals are not removed, they can degrade the image and cause the dye to fade. 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 can enter the emulsion to remove the chemicals, but not so warm that it damages the emulsion. For more information on washing, see Section 2, *Using KODAK EKTACOLOR RA Chemicals in Photofinishing Labs*.

### Stabilizer

Washless (non-plumbed) minilabs use a stabilizer instead of a wash step. An optional cycle for roller-transport processors also uses a stabilizer to conserve water. The stabilizer removes residual chemicals from the paper.

### Checking Prints for Retained Silver

Inadequate bleach-fixing can lead to retained silver in prints. High levels of retained silver affect print quality and can also give false signals to sensors used in automatic print choppers.

Inadequate bleach-fixing is caused by dilute or underreplenished bleach-fix, a short bleach-fix time, or a low temperature (or a combination of these conditions). The most common cause is dilution of the bleach-fix due to ineffective developer squeegees and excessive developer carryover.

To check prints for retained silver, compare the processed control strip with the reference strip by using an infrared scope in a darkroom. When you view the control strip through the scope, the dye image will appear nearly invisible. If your process does not have a retained-silver problem, the reference strip and your control strip should look the same. If the process does have a retained-silver problem, the silver image in the control strip will be visible as a darker density, most evident in the black patch.

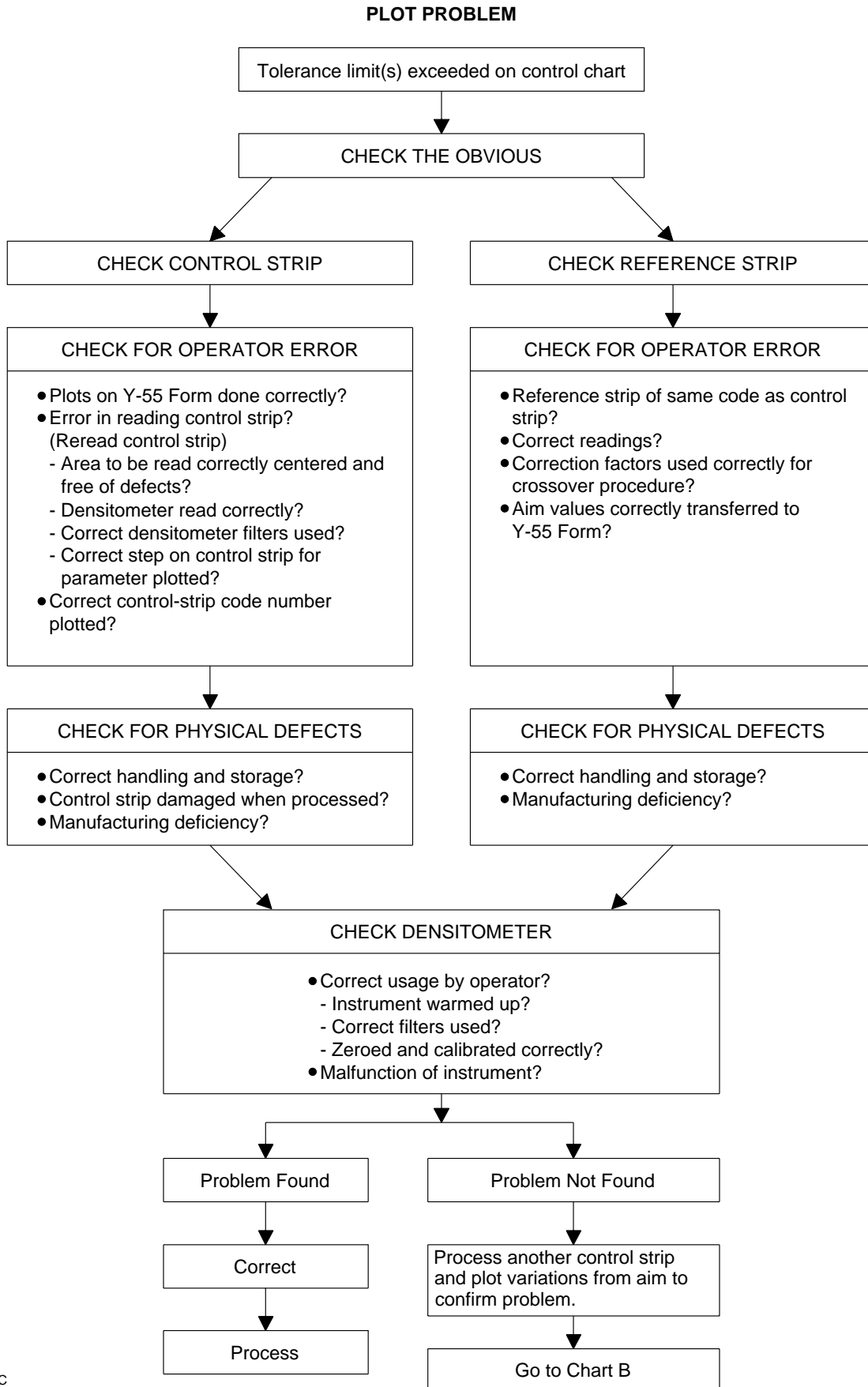
Infrared scopes are available from several sources; check the yellow pages of your telephone directory under *Scientific Apparatus and Instruments*.

## DIAGNOSTIC CHARTS

The diagrams in this section provide you with a step-by-step approach to diagnosing process problems. The preliminary and summary charts show which detailed chart to check for your problem. The charts give probable causes and suggest corrective actions.

Chart	Title
A	Preliminary
B	Summary—Control-Chart Plots
C	Control-Chart Plots—High BP, HD-LD, or LD
D	Control-Chart Plots—Low BP, HD-LD, or LD
E	Control-Chart Plots—High D-min
F	Control-Chart Plots—Visual Appearance—Developer and Bleach-Fix
G	Control-Chart Plots—Visual Appearance of Paper
H	Control-Chart Plots—Visual Appearance of Paper
I	Control-Chart Plots—Visual Appearance of Paper

**Chart A  
Preliminary**



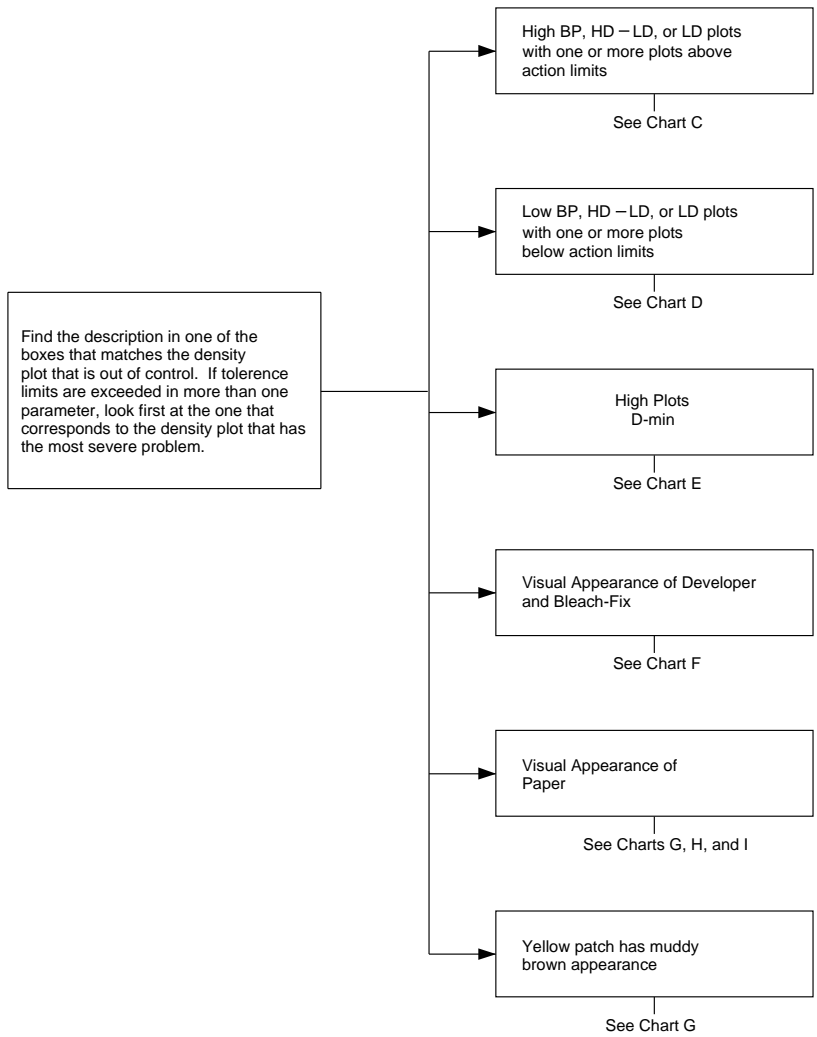
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# Chart B Summary—Control-Chart Plots

## DESCRIBE PLOT PATTERN

## FURTHER IDENTIFY AND GO TO SPECIFIED CHART



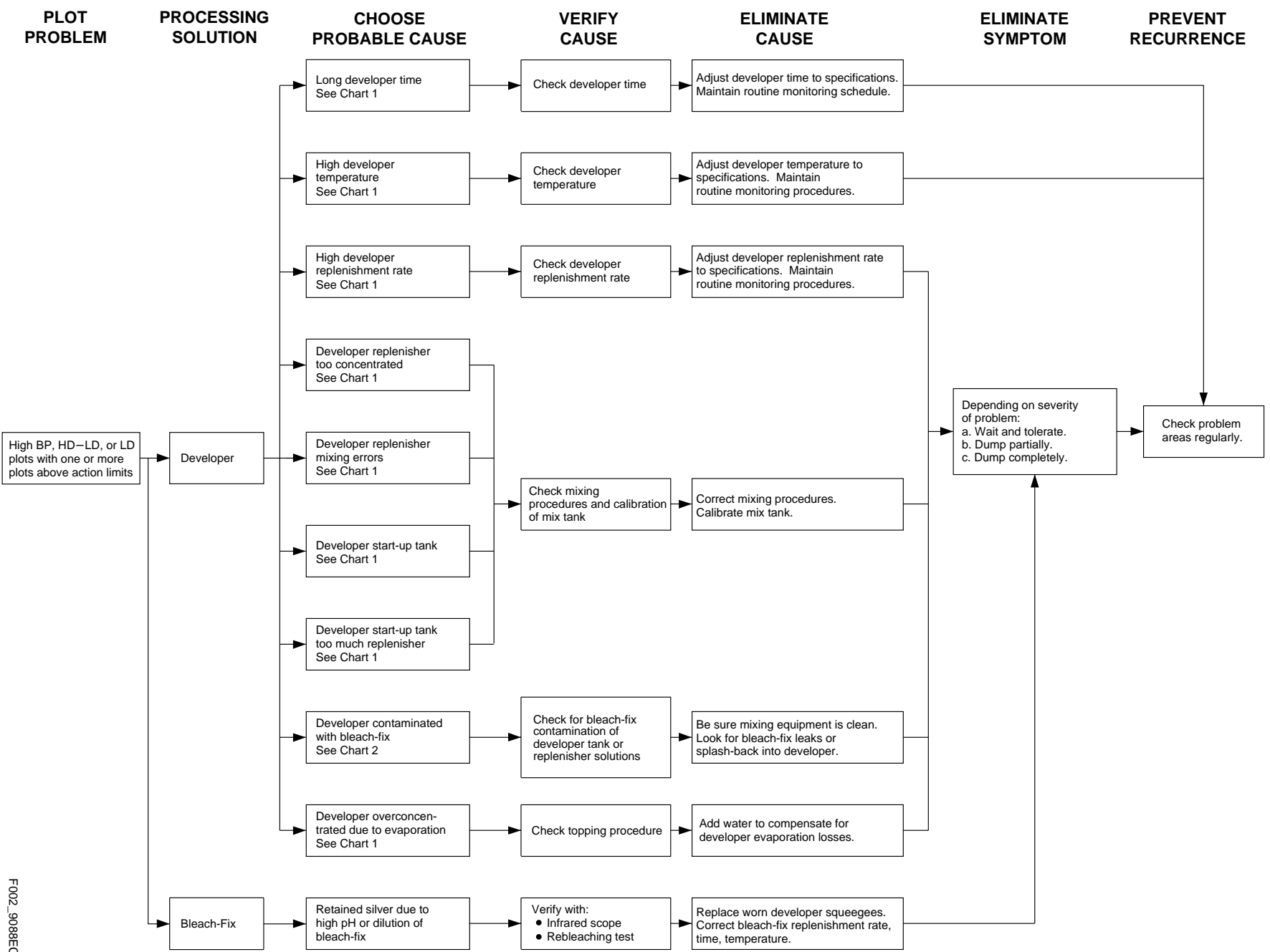
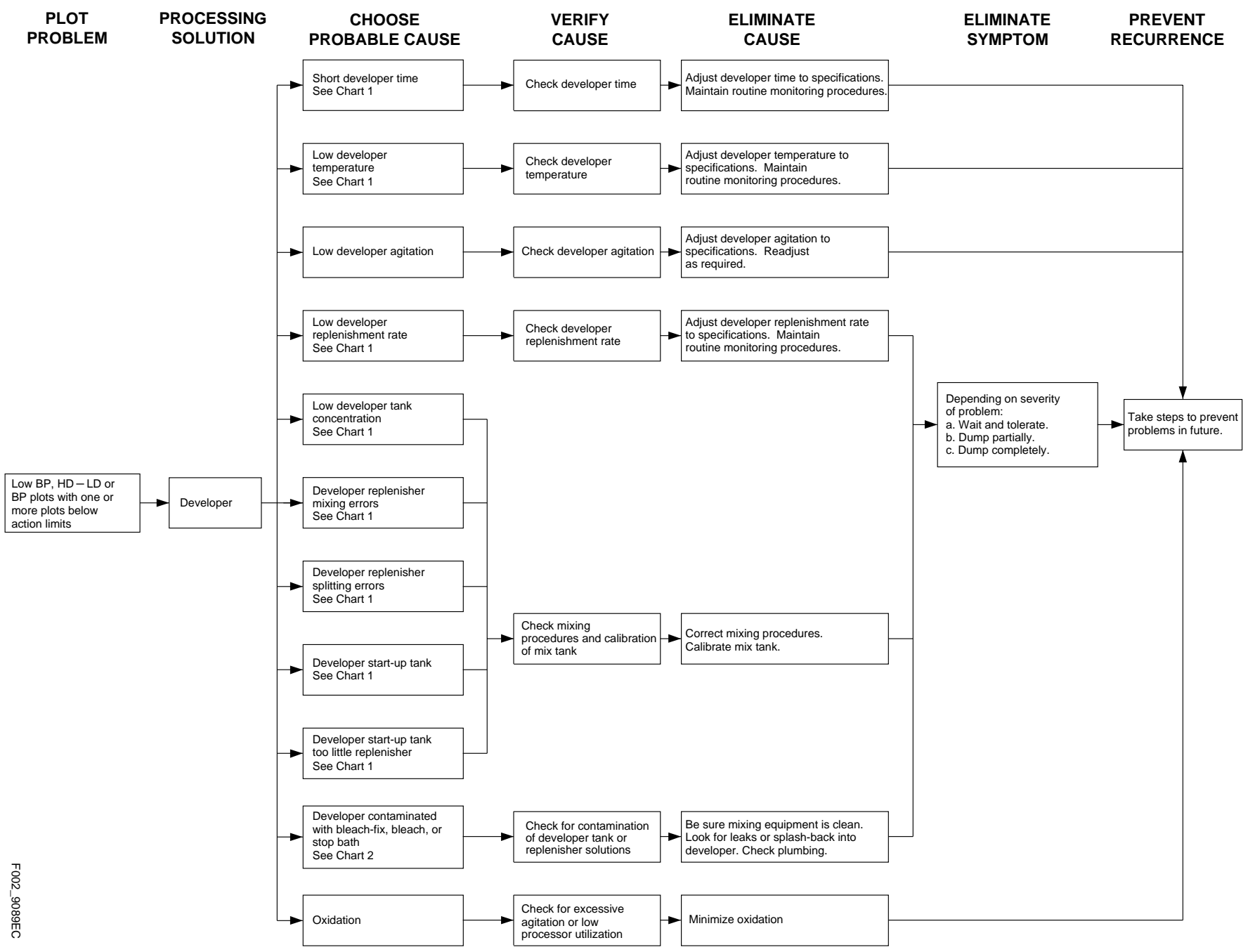


Chart C  
Control-Chart Plots—High BP, HD – LD or LD

**Chart D**  
**Control-Chart Plots—Low BP, HD – LD or LD**



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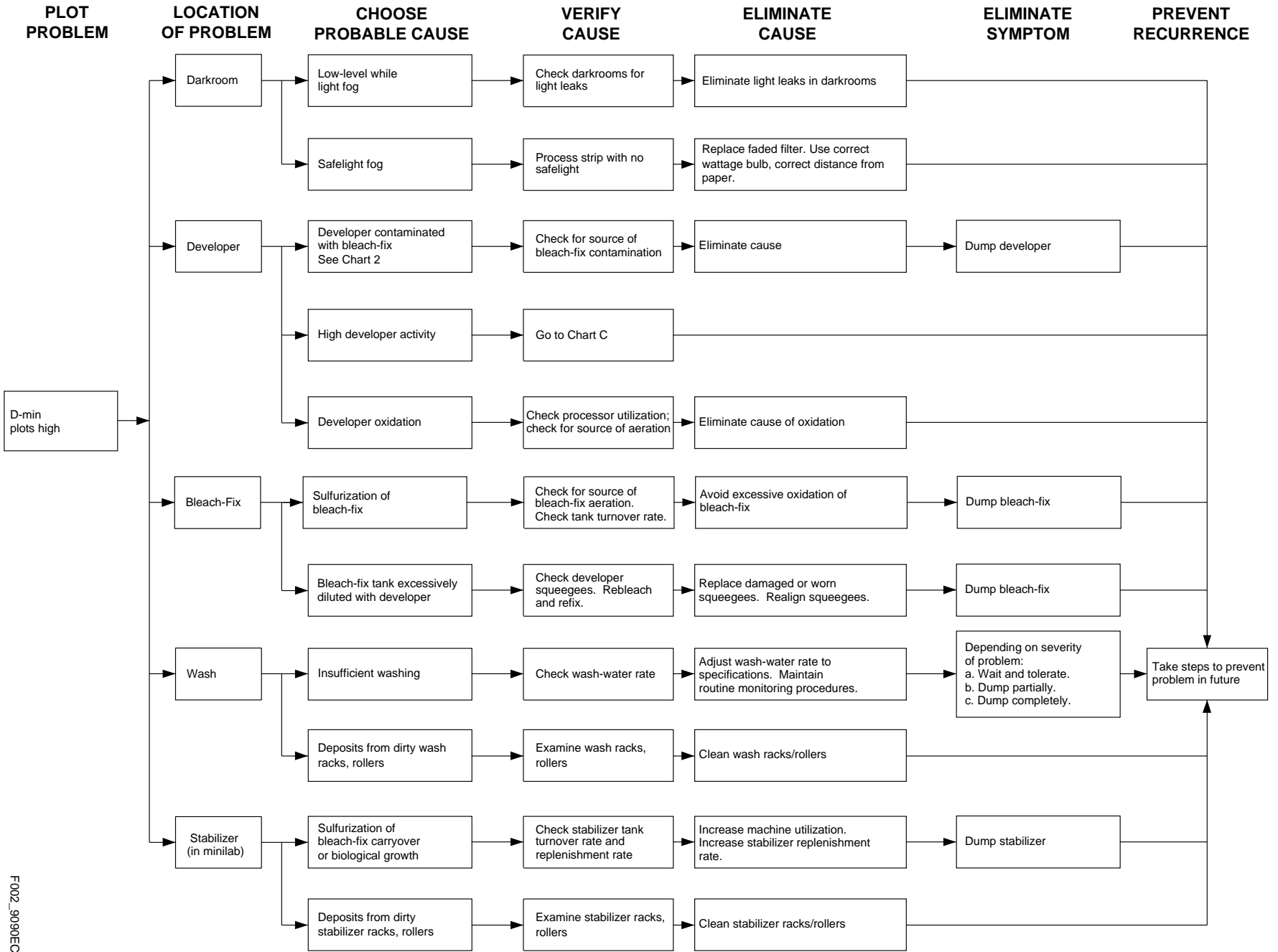
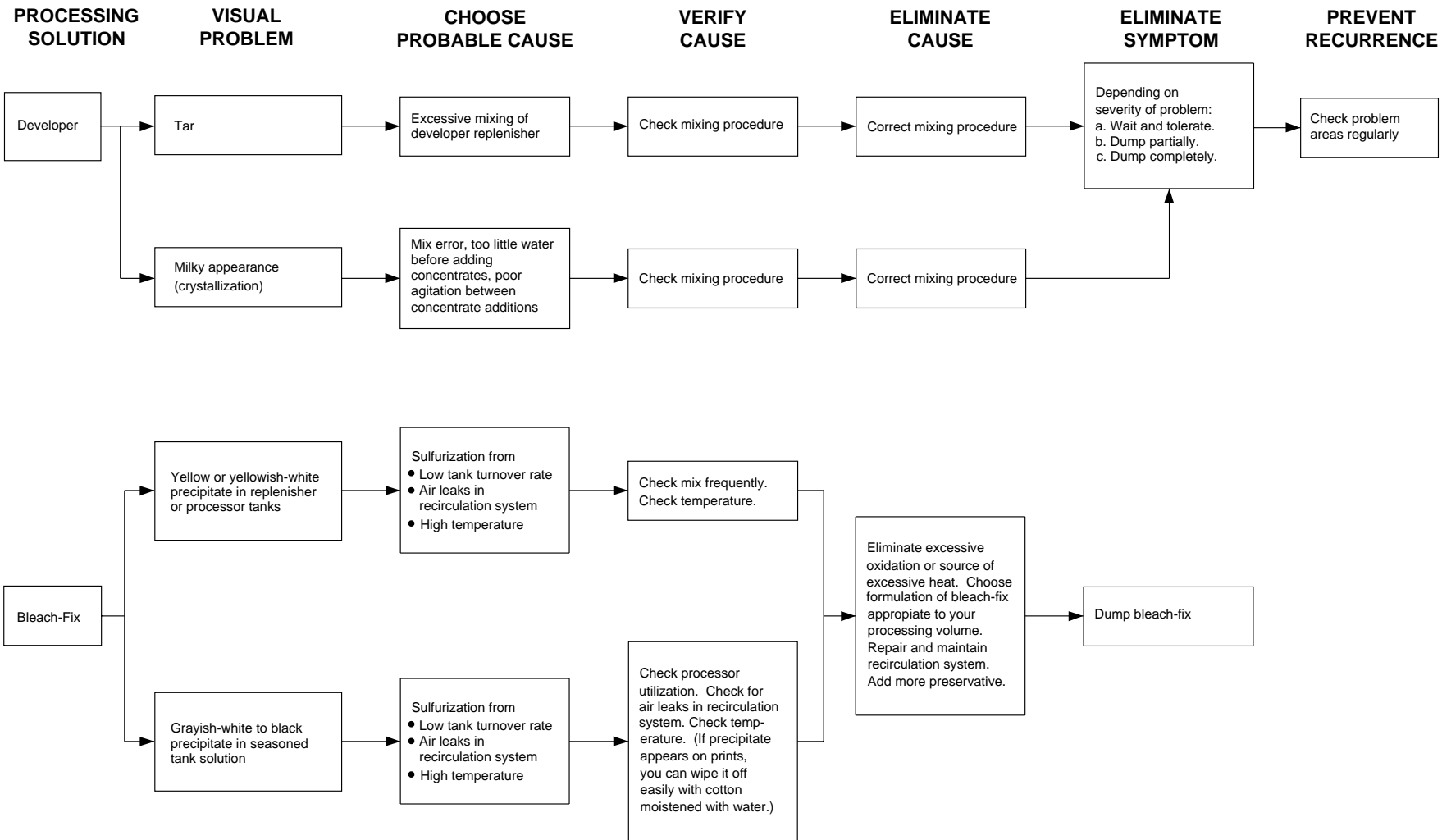


Chart E  
Control-Chart Plots—High D-min

**Chart F**  
**Control-Chart Plots—Visual Appearance – Developer and Bleach-Fix**



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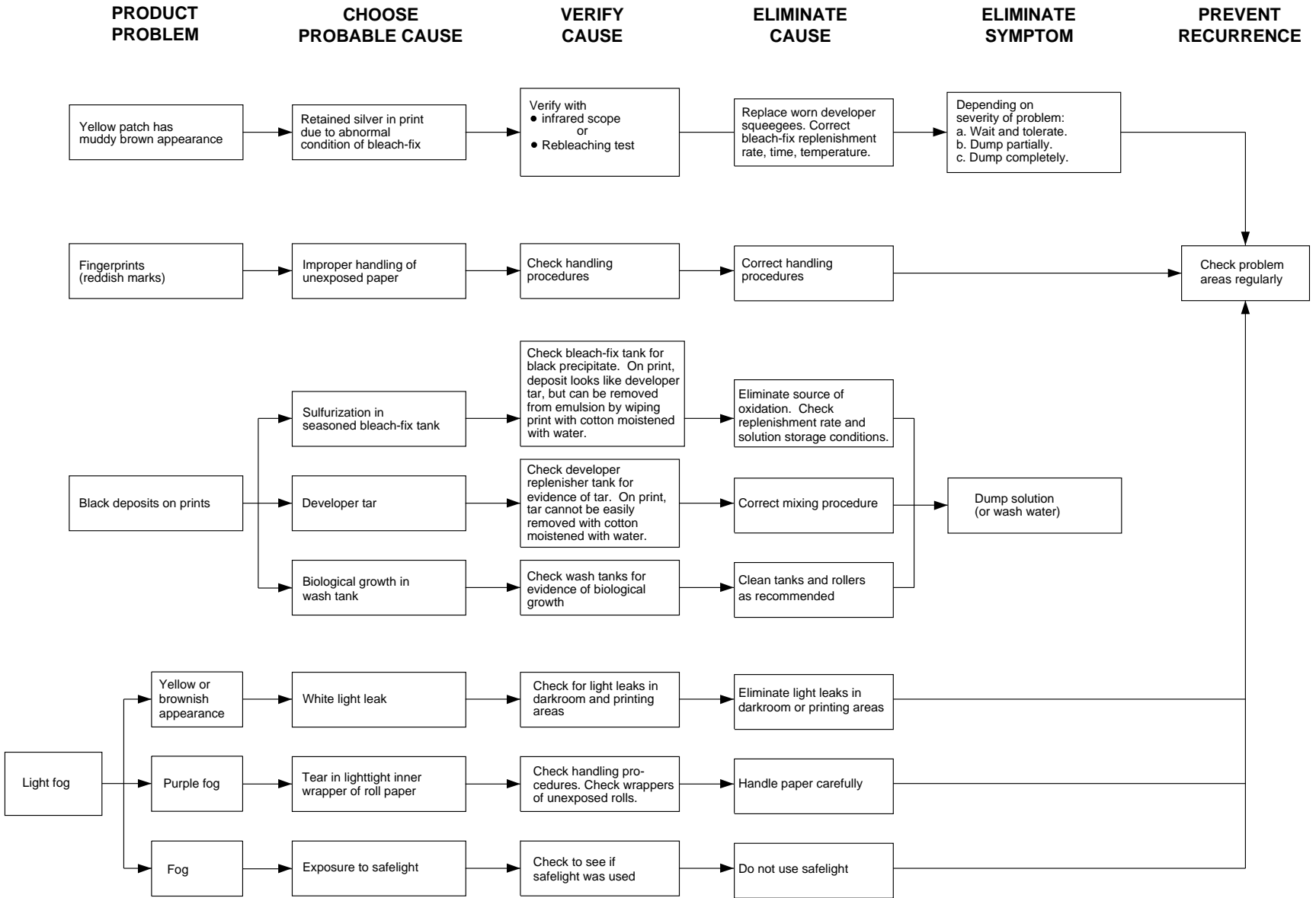
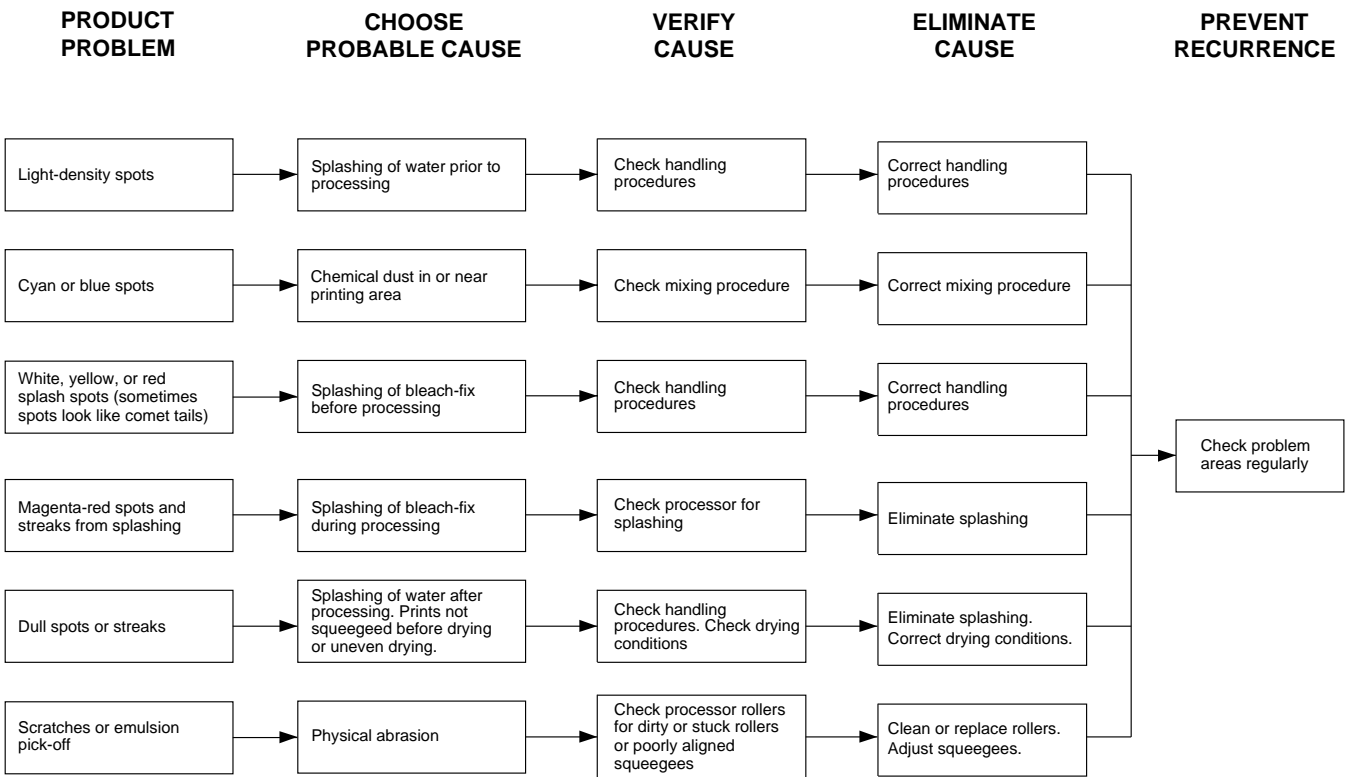
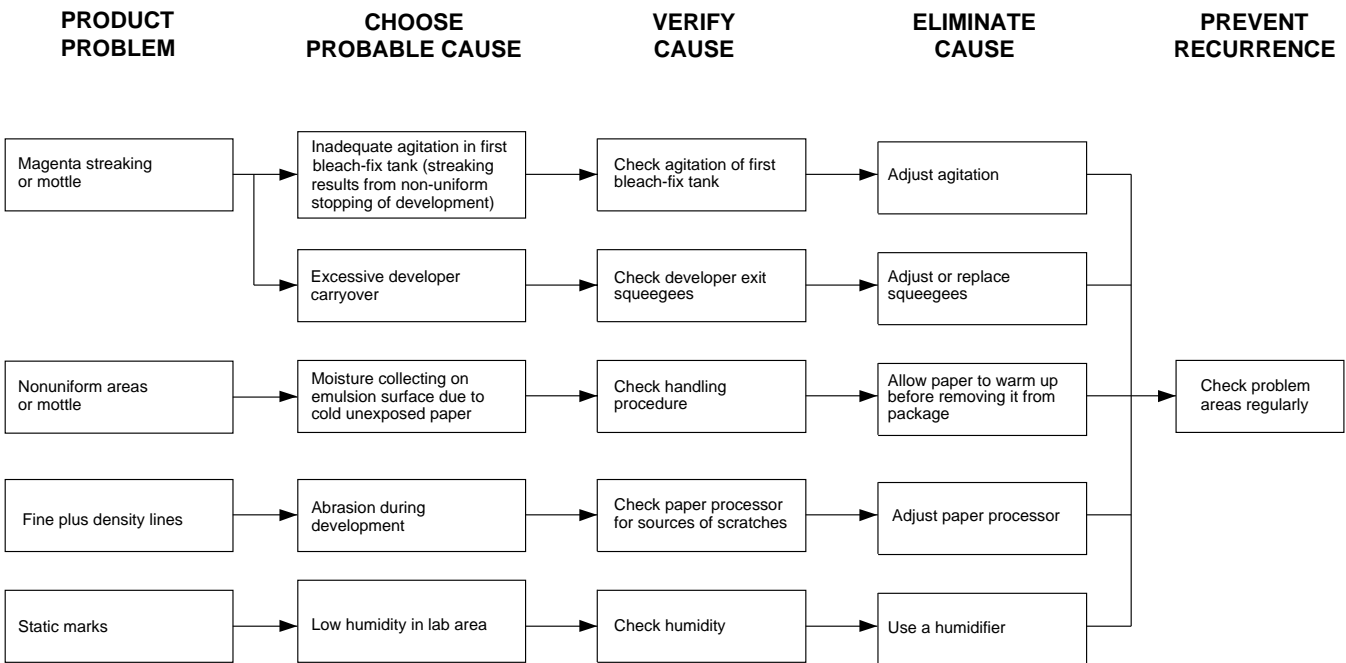


Chart G  
Control-Chart Plots—Visual Appearance of Paper

**Chart H**  
**Control-Chart Plots—Visual Appearance of Paper**



**Chart I**  
**Control-Chart Plots—Visual Appearance of Paper**





## CONTROL-CHART EXAMPLES

Generally, the control-plot patterns you can detect when you use KODAK Control Strips, Process RA-4, result from processing problems that can be summarized in the following three charts. The charts are intended *only as guides*; your plots may not look exactly like these examples.

The exact appearance of the control plot depends on the specific mechanical design of the processor and the condition of the chemical concentrations in the processor tank. You may also have more than one problem affecting your process. Beside each chart is a description of potential causes and remedies for problems.

Use these charts with the *DIAGNOSTIC CHARTS* and the descriptions under *INTERPRETING YOUR CONTROL PLOT* to analyze process problems.

Chart	Solution	Condition
1	Developer	Developer Activity
2	Developer	Contamination with Bleach-Fix
3	Bleach-Fix	Leuco-Cyan Dye

Although we have not included a control plot pattern for the effects of developer oxidation, a discussion of the results you can expect and the possible remedies follows the control chart examples.

## Developer Activity

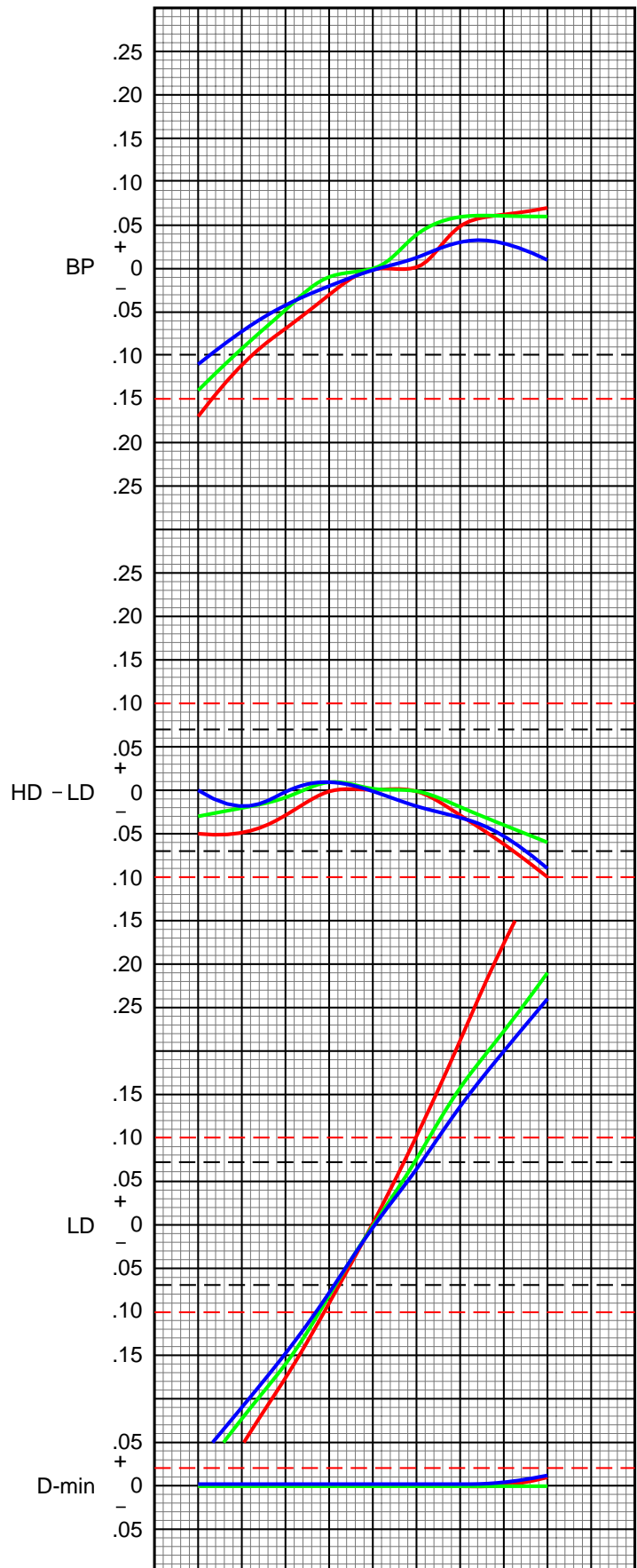
### Developer—High or Low Activity

When the developer activity is too high relative to the process aim, the density of the processed materials will be too high, and the prints will be dark. If the developer activity is too low, the prints will be too light.

High and low developer activity have several potential causes. They all produce control-plot patterns very similar to that shown in Chart 1. The process problems that would cause the large shifts shown in Chart 1 would result from gross errors in operation. For example, a low-temperature shift of  $-11^{\circ}\text{F}$  or a high-temperature shift of  $+11^{\circ}\text{F}$  would cause shifts of the magnitude plotted here.

If your problem is caused by high or low developer activity, you should consider each of the potential causes. Also, be aware that the condition may have more than one cause, or one problem may be partially compensating for another. When you detect a developer-activity problem, it is good practice to verify all the operational conditions for the processor.

**Chart 1**



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### **Developer—Time Too Short or Too Long**

The recommended developer time for Processes RA-4 is 45 seconds. If the developer time is too short or too long, it will affect development and the amount of dye formed.

Developer times that are too long will produce higher-than-normal LD, HD – LD, and BP density values.

Developer times that are too short will produce lower-than-normal LD, HD – LD, and BP density values.

Developer-time variations can occur in processors because of variations in electrical load and differences in motor temperature from a cold start to equilibrium. Electrical-load variations 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 processor 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. Extended developer times can also result from intermittent paper slippage in the developer tank. Use a stopwatch to measure the developer time, and compare it with the machine setting.

### **Developer—Temperature Too Low or Too High**

The recommended developer temperature for Process RA-4 is  $35 \pm 0.3^{\circ}\text{C}$  ( $95.0 \pm 0.5^{\circ}\text{F}$ ) for KODAK EKTACOLOR RA Developer Replenisher or KODAK EKTACOLOR RA Developer Replenisher RT. For EKTACOLOR Developer Replenisher 12 (EKTACOLOR Developer Replenisher 161 in Europe) and EKTACOLOR PRIME Developer Replenishers, the recommended temperature is  $37.8 \pm 0.3^{\circ}\text{C}$  ( $100.0 \pm 0.5^{\circ}\text{F}$ ).

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 the developer had enough time to reach operating temperature before processing.
- Check that the temperature of the replenisher solution was not too low or too high.
- If your processor has more than one developer tank, check that the temperature is the same in all tanks. Check that the temperature within each tank is uniform from top to bottom and side to side.
- Check that the developer recirculation filter is not clogged. A clogged filter can prevent proper heating of the solution. Check for constricted circulation lines.

The temperature controller and the recirculation system—individually or in combination—can cause temperature problems. Replace the recirculation filters if they are clogged.

If the temperature of the developer replenisher is too low or too high, it may be affecting the temperature of the tank solution. If this occurs, you may need to provide more heat in the replenisher storage area or heat the replenisher before using it.

Check the developer temperature frequently, and adjust it as necessary. Also, check the developer temperature periodically while the processor is operating under full load. The heater may not be able to maintain the temperature as fresh replenisher and a maximum load of paper are entering the developer.

## Developer—

### Replenishment Rate Too Low or Too High

Developer activity varies directly with the replenishment rate. If the rate is too low, the LD, BP, and HD – LD density values will plot lower than normal. If the rate is too high, the density values for LD and BP will plot higher than normal. The amount of change that you see in control-strip plots due to incorrect replenishment depends on the developer-tank volume, processor speed, and the amount of paper processed.

The recommended replenishment rates are *starting points only*. The exact rate depends on the type of processor and replenisher mixing and storage conditions. It can also depend on how well you maintain operating conditions, such as development time and temperature. Determine your exact rate by monitoring the process with control strips and adjusting the rate as needed according to the control plots. **Do not** adjust the rate to “chase” small changes in the control plots. Once the process is in control, continue to use the rate you established; don’t change it unless processor utilization changes. Be aware that the rate of change after a replenishment-rate adjustment may be relatively slow; you may not see the full impact of a developer replenishment-rate change for several weeks.

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

If you suspect that replenishment is the problem:

- Check that the replenishment system is set correctly.
- Check that your calculations are correct if you set your replenishment rate for the average paper width being processed. Does the paper width vary seasonally? Check your replenishment rate by using this calculation.

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

- Check that the processor was receiving replenishment when you detected the problem.
- Check for a possible mechanical problem with the replenishment system. Is the system replenishing at a constant and repeatable rate?

If *underreplenishment* is the cause of the problem, adjust the replenishment rate to the correct rate. To correct the underreplenished processor tank condition, remove enough developer tank solution so that you can add replenisher in 5- to 10-percent increments of tank volume. Repeat if needed to correct the tank condition. After each addition, recirculate the developer for approximately 10 minutes before you process another control strip.

If *overreplenishment* is the cause of the problem, adjust the replenishment rate to the correct rate. To correct the overreplenished processor tank condition, remove enough developer tank solution so that you can add water and starter to bring the process back into control. Add one part starter to 11 parts water. If the process is not far out of control, add the water and starter in 5-percent increments of tank volume. If the process is grossly out of control, add water and starter in 10-percent increments. After each addition, recirculate the developer for approximately 10 minutes before you process another control strip. If the process is still out of control after you have added water and starter equivalent to 20 percent of the tank volume, replace the tank solution with a fresh mix.

### **Developer—Fresh-Tank Mixing Error—Too Little or Much Starter**

Using *too little* starter in a fresh developer mix will increase developer activity. You will see this in the control plots as an increase in the LD and HD – LD density values.

Using *too much* starter for a fresh developer tank solution decreases developer activity. You will see this in the control plots as a decrease in the LD, HD – LD, and BP density values.

To avoid these fresh-tank mixing errors, carefully follow the directions provided with the developer.

If you know the amount of starter that was left out, you can add the missing amount. If you added too much starter or do not know the amount of the error, it will be difficult to correct the problem without a chemical analysis. Replace the tank solution with a fresh mix.

### **Developer—Mixing Error—Incorrect Water/ Replenisher Ratio**

Developer activity is affected by a mix that is prepared with too little replenisher and topped with water, or with too little water and topped with replenisher.

Using too much water and too little replenisher has the greater effect. You will see this as lower-than-normal LD, HD – LD, and BP values in the control plots.

If you use too much replenisher and too little water, the effect in the control charts will be slight.

Review your mixing procedures and verify the mix-tank calibration. Follow the mixing order in the instructions provided with the chemicals.

Because it is very difficult to determine the exact cause or amount of this type of mixing error without chemical analysis, replace the solution with a fresh mix.

### **Developer—Replenisher Mixing Error—Too Little or Too Much Part A**

Using the wrong amount of any of the developer components affects developer activity. Too little Part A causes high activity; too much Part A causes low activity.

Omitting Part A entirely usually results from human error. However, the chance of leaving out just a portion increases if you split the packaged developer to mix a smaller volume. Errors of 5 to 10 percent will affect the control plots. Be sure that your measuring device is accurate and that you use it correctly. Check that you have calculated the amounts correctly, and that you added the correct amount.

To reduce errors, always use accurate measuring equipment. Graduated cylinders calibrated in millilitres, not ounces, are the most accurate. If you use an automatic mixer, be sure it is properly calibrated for the volumes being mixed. Review mixing procedures for possible sources of error.

Because it is very difficult to determine the exact cause or amount of this type of mixing error without chemical analysis, replace the solution with a fresh mix.

### **Developer Replenisher Mixing Error—Too Little or Too Much Part B**

Using the wrong amount of any of the developer components affects developer activity.

Omitting Part B entirely usually results from human error. However, the chance of leaving out just a portion increases if you split the packaged developer to mix a smaller volume. Errors of 5 to 10 percent will affect the control plots. Be sure that your measuring device is accurate and that you use it correctly. Check that you have calculated the amounts correctly, and that you added the correct amount.

To reduce errors, always use accurate measuring equipment. Graduated cylinders calibrated in millilitres, not ounces, are the most accurate. If you use an automatic mixer, be sure it is properly calibrated for the volumes being mixed. Review mixing procedures for sources of possible error.

Because it is very difficult to determine the exact cause or amount of this type of mixing error without chemical analysis, replace the solution with a fresh mix.

### **Developer—Replenisher Mixing Error—Too Little or Too Much Part C**

Using the wrong amount of any of the developer components affects developer activity. Too little Part C causes low activity; too much Part C causes high activity.

Omitting Part C entirely usually results from human error. However, the chance of leaving out just a portion increases if you split the packaged developer to mix a smaller volume. Errors of 5 to 10 percent will affect the control plots. Be sure that your measuring device is accurate and that you use it correctly. Check that you have calculated the amounts correctly, and that you added the correct amount.

To reduce errors, always use accurate measuring equipment. Graduated cylinders calibrated in millilitres, not ounces, are the most accurate. If you use an automatic mixer, be sure it is properly calibrated for the volumes being mixed. Review mixing procedures for sources of possible error.

Because it is very difficult to determine the exact cause or amount of this type of mixing error without chemical analysis, replace the solution with a fresh mix.

## Developer—Contamination With Bleach-Fix

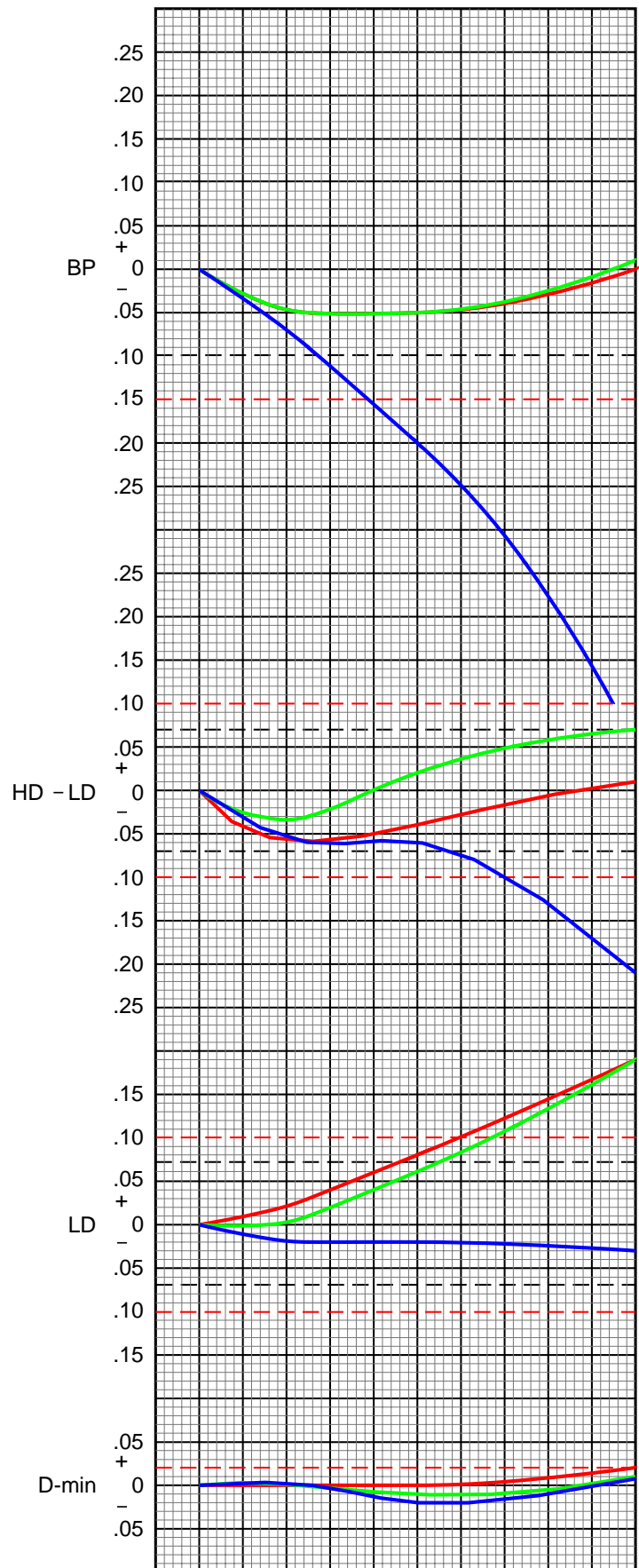
Chart 2 demonstrates that very small amounts of thiosulfate (also called hypo) from the bleach-fix will contaminate the developer. As little as 0.1 mL of bleach-fix per litre of developer can put a process out of control. If the developer is contaminated with bleach-fix, you will see a severe color change in the prints and large shifts in the control plots. You will also see an increase in D-min.

The chart shows the typical plot pattern that results from bleach-fix contamination of a developer tank. The degree of contamination is severe in this example; the most severe contamination shown is at 2.4 mL of EKTACOLOR RA Bleach-Fix NR Replenisher per litre of developer.

Possible causes of bleach-fix contamination are bleach-fix splashed into the developer when the racks are raised or mixing developer with equipment that contains a small amount of bleach-fix. Check for any procedures that might cause splashing during mixing or processing. If possible, use separate mixing tanks for developers, and wash all mixing equipment thoroughly before reusing it.

Stop production until you find the source of the contamination. A developer contaminated with bleach-fix or fixer cannot be salvaged; replace it with a fresh mix.

### Chart 2



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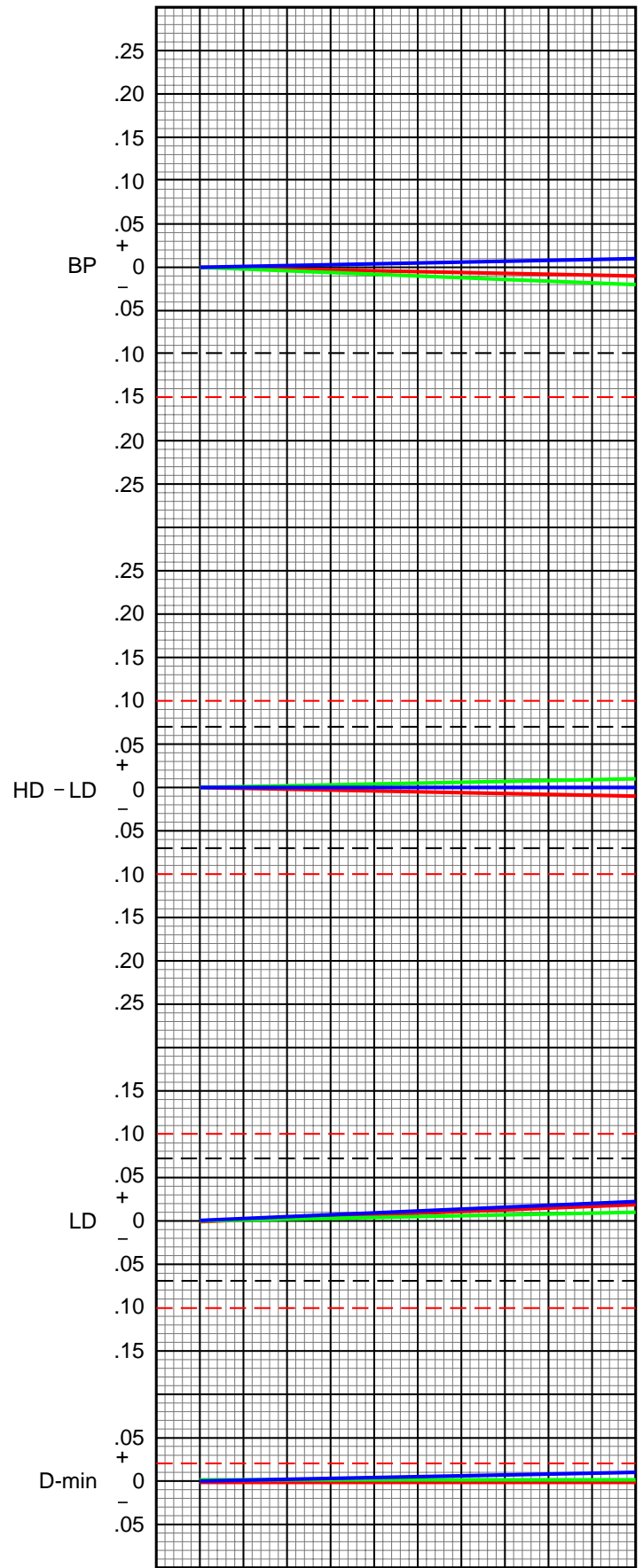
### Bleach-Fix—Leuco-Cyan Dye

With earlier versions of EKTACOLOR Edge Papers, low bleach-fix pH could lead to the formation of a colorless form of cyan dye called leuco-cyan dye. This condition produced prints with a reddish cast in the higher neutral-density regions of the image.

EKTACOLOR Edge 8 Paper is virtually insensitive to the conditions that caused leuco-cyan dye in the older generations of paper. Chart 3 demonstrates no significant impact as the pH is reduced from pH 6.2, a standard pH condition, to pH 4.8.

**Note:** At this time, the KODAK PROFESSIONAL Papers and PROFESSIONAL Print and Display Materials are still sensitive to the formation of leuco-cyan dye when the bleach-fix tank pH is too low. For this reason, we recommend that labs use KODAK PROFESSIONAL Pro Strips, Process RA-4 to monitor processing of KODAK PROFESSIONAL Papers and Materials.

**Chart 3**



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## **Developer—Oxidation**

When developer is exposed to air, it reacts with oxygen. To protect the developing agent, developers contain preservatives that react with oxygen. However, prolonged exposure to air will eventually deplete the preservatives and cause the developing agent to oxidize. Oxidation of the developing agent causes decreased developer activity and precipitate formation.

It is difficult to produce a representative plot pattern for the effects of developer oxidation, because it depends on the degree of aeration of the tank. Also, if you adjust your developer replenishment rate in an attempt to reduce the process control bias, you may be masking the impact of the oxidation. Generally, you will see an increase in BP, HD – LD, and D-min in the control plots.

The most common causes of oxidation are excessive agitation and low processor utilization. Excessive agitation—e.g., from long or too rapid mixing or too much agitation in the processor—forces air into the solution. A faulty processor recirculation pump can also suck air into the solution. Foaming may indicate that the recirculation system is leaky and is sucking air.

Oxidation is a more common problem in roller-transport processors than in other type 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, and leads to overconcentration of the developer. Overconcentration may offset some of the effects of the oxidation and mask the condition.

Minimize oxidation by turning off the processor when it is not in use. In roller-transport processors, use solutions that contain extra protection against oxidation, such as KODAK EKTACOLOR RA Developer Replenisher RT.

Check for excessive air flow over the processor developer tanks and developer replenisher storage tanks. Use floating lids on storage tanks. Avoid overmixing and excessive agitation.