Processing EASTMAN EKTACHROME Color Reversal Films, Module 14

Effects of Mechanical & Chemical Variations in Process RVNP

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14 Effects of Mechanical & Chemical Variations in Process RVNP

INTRODUCTION

Process RVNP provides rapid-access processing of the news and print films through either of two process sequences. The two sequences are identified as Sequence P-1 and Sequence P-2. Process wet time has been reduced from 14:15 in Process VNF-1 to 7:42 in Sequence P-1, and to 7:52 in Sequence P-2 of Process RVNP.

The reduction in process time is accomplished through the use of:

- Increased machine speed.
- Additional decreases in some solution times.
- Increased solution temperature.
- Reduced safety factor.
- Persulfate Bleach and Accelerator in place of Ferricyanide Bleach.

Process Control

The successful processing of the designated films requires a good process control system. The essential phases of such a control system include mechanical, chemical, and photographic control, plus correlation and interpretation of results.

The designated films for Process RVNP are:

EASTMAN EKTACHROME Film 7239 (Daylight)

EASTMAN EKTACHROME Film 2239 / ESTAR Base

EASTMAN EKTACHROME Film 7240 (Tungsten)

EASTMAN EKTACHROME High Speed Film 7250 (Tungsten)

EASTMAN EKTACHROME High Speed Daylight Film 7251

EASTMAN EKTACHROME High Speed Daylight Film 2253 / ESTAR Base

EASTMAN EKTACHROME Print Film 5399 / 7399

The philosophy and a recommended system of process control are given in Module 1, *Process Control*. The following sections are specific for Process RVNP.

Mechanical Control

Mechanical control includes items basic to any chemical reaction, such as temperature, agitation, and time of reaction. Maintain the Process RVNP developer temperatures tightly within specifications. Control the temperatures of the other solutions within specifications also, even if not quite so critical. Regulate recirculation and replenishment rates to maintain the required chemical activity of the various solutions. Pipe turbulated solutions through devices that indicate the rates of flow and pressures so that the jet-agitation action of the solution at the film surface can be controlled. A method for calibrating and measuring flow rates is given in Module 2, *Equipment and Procedures*. Check the operating speed of the processing machine frequently. All such factors, whether regulated automatically or manually, constitute the physical or mechanical aspects of control. A checklist for daily operation of a Process RVNP machine is given in Figure 14-1.

Chemical Control

Maintaining the proper composition of the processing solutions is one of the most important elements of control. For satisfactory process control, the chemical composition of the solutions must be maintained to specifications rather than to compensate for poor mechanical control.

Analytical Methods recommended in Module 3, *Analytical Procedures* determine the chemical composition of each processing solution. Some of the methods require the use of a pH meter for the accurately measurement of solution acidities or alkalinities or for potentiometric titrations. A spectrophotometer can be useful to measure some constituents in the processing solutions. With these two instruments plus chemical reagents and the assorted glassware (pipets, burets, hydrometers, beakers, etc.) usually found in analytical laboratories, all of the solutions used in the process can be analyzed. Table 14-1 presents all the analyses and their method numbers that can be performed in Process RVNP. All fresh chemical mixes, rejuvenated and reconstituted mixes should be analyzed completely as the first defense against mixing errors. The tank solutions should be checked on a regular basis to monitor any changes in the chemical composition of these solutions. Some factors evaluated, such as developer pH, are more critical to good film results than other factors, such as the level of sodium sulfite, in the developer.

Table 14-1 indicates which of the factors are critical and should be checked more frequently than the others. During normal operation, analyze the pH of the color developer daily, the less critical constituents weekly, and the noncritical constituents monthly. The schedule of analysis to be used by a particular installation to keep its process in chemical control depends on the amount of film processed and the stability of the process.

Figure 14-1 Critical Chemical Analyses for Process RVNP

Solution	Analyses	Critical Analyses		Method Number
		Tank	Replenisher	
First Developer	pH	W, F	F	ULM-191-2
	Specific Gravity	M, F	F	ULM-0002/1
	Total Alkalinity	M, F	F	ECR-702J
	Sodium Sulfite	M, F	F	ECR-1305L
	Hydroquinone	W, F	F	ECR-440B
	Phenidone*	W, F	F	ECR-440B
	Potassium Iodide	W, F	F	ECR-929C
	Sodium Bromide	W, F	F	D94-0001/1
	Sodium Thiocyanate	W, F	F	D94-0003/1
Stop Baths	pH	W, F	F	ULM-191-2
Color Developer	pH	D, F	F	ULM-191-2
	Specific Gravity	M, F	F	ULM-0002/1
	Total Alkalinity	M, F	F	ECR-702J
	Benzyl Alcohol	M, F	F	ECR-1603E
	CD-3	W, F	F	ECR-125F
	Potassium Iodide	M, F	F	ECR-925A
	Sodium Sulfite	M, F	F	ECR-1303
	Sodium Bromide	M, F	F	ECR-930E
	RA-1	W, F	F	ECR-1470C
	Citrazinic Acid	W, F	F	ECR-1611D or ECR-1612
	Ethylenediamine	W, F	F	ECR-617B
Accelerator (Persulfate Bleach)	pH	M, F	F	ULM-191-2
	Specific Gravity	M, F	F	ULM-0002/1
	PBA-1	W, F	F	ECR-2100B
	Sodium Sulfite	M, F	F	ECR-1340A
	Buffer Capacity	M, F	F	ECR-755A
Persulfate Bleach	pH	W, F	F, R	ULM-191-2
	Specific Gravity	M, F	F, R	ULM-0002/1
	Sodium Persulfate	W, F	F, R	ECR-1125B
	Sodium Chloride	W, F	F, R	ECR-937
	Buffer Capacity	M, F	F, R	ECR-754A
Fixer	pH	M, F	F, R	ULM-191-2
	Specific Gravity	M, F	F, R	ULM-0002/1
	Hypo Index	M, F	F, R	ECR-1308J
	Sodium Sulfite	M, F	F, R	ECR-1308J
	Thiosulfate	M, F	F, R	ECR-1308J
Stabilizer	Formalin	M, F	F	ECR-1803G

F=All Fresh Mixes R=Rejuvenated or reconstituted D=Daily W=Weekly M=Monthly

* Phenidone is a trademark of Ilford (Ciba-Geiga Company)

Table 14-1 Checklist For Daily Operation

Steps		Spec.	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
1. Was shutdown strip in control?									
2. Turn on power, air and water supplies, and the exhaust system.									
3. Check solution levels* in machine tanks.									
4. Check replenisher supply tanks and make fresh replenishment solutions (if necessary).	First Developer								
	First Stop								
	Color Development								
	Accelerator								
	Bleach								
	Fixer								
	Stabilizer								
5. Turn on recirculation pumps.									
6. Adjust wash-water flow-meters to proper setting.									
7. Turn on and check air supply to squeegees.									
8. Turn on temperature controls systems.									
9. Turn on replenishers. Use leader rates until film is being processed.									
10. Turn on dryer fan motor and heater.									
11. Start machine and check machine speed.									
12. Check final squeegee for cleanliness and adjustment. Make corrections if necessary.									
13. Check leader for twists.									
14. Check solution time.	First Developer								
	Color Developer								
15. Use KODAK Process Thermometer, Type 3. Check solution temperature.†	First Developer								
	Color Developer								
16. Check recirculation rate.	First Developer								
	Color Developer								
	Accelerator								
	Bleach								
	Fixer								
17. Run control strips.									
18. Proceed to production if in control.									
19. Check replenisher flow rate.†	First Developer								
	First Stop								
	First Wash								
	Color Developer								
	Second Stop (P2)								
	Accelerator								
	Second Wash (P1 Option)								
	Bleach								
	Fixer								
	Final Wash								
	Stabilizer								

* Solution levels must be high enough in the weir boxes to prevent air from being drawn into the recirculation systems when recirculator pumps are turned on.
† Start-up and every two hours.

Photographic and Sensitometric Control

The chemical reactions involved in processing color films are so complex that it is impossible to evaluate and control the process completely on the basis of mechanical and chemical data alone. The end results are photographic and include the characteristics of the sensitized material and the chemicals of the process. Actual picture tests can demonstrate how the process behaves photographically, and it is possible to use such tests for photographic control. Picture rests are always desirable because quality evaluations must be determined from the finished picture.

However, it is preferable to use methods that will furnish quantitative information about the process. A rapid and accurate means of evaluating the process photographically is provided by sensitometric strips that greatly simplify the evaluation and control of the process. These strips can be included in the process with regular production footage as often as desired and evaluated visually or, more precisely, by densitometric methods. The strips can be examined immediately after processing and the results can be plotted on charts near those on which the mechanical and chemical data are recorded. Such information gives an hour-to-hour check on whether accidents have occurred to move the process to drift away from normal.

For the convenience of processors, sensitometrically exposed control strips in 16 and 35 mm are available from Eastman Kodak Company. KODAK Control Strips, Process VNF-1 (used for Process RVNP) are packaged in 100-foot rolls containing at least 120 exposures and a processed reference strip. The exposures on the roll are spaced at 9.5-inch intervals. Each exposure has 11 gray-scale steps at 0.30 log H increments (one camera stop). The reference strip is exposed exactly as the control strips and is subsequently processed under well-controlled conditions. An instruction sheet is included which contains correction factors that are required to establish customer process aims. A four-digit code number appearing on the carton, can, control strips, reference strips, and instruction sheet identifies each production batch of strips. The procedures for using control strips are found in Module 1, *Process Control*.

Correlation of Mechanical, Chemical, and Sensitometric Data

All results—mechanical, chemical, and photographic—should be recorded and interpreted to monitor whether the process is in or out of control. If the process drifts out of control, the control records should indicate what corrective action was taken to reestablish control.

As experience is gained with Process RVNP, mechanical, chemical, and sensitometric data will be accumulated, which can serve as references to indicate what may be expected in the photographic results when various mechanical and chemical changes occur.

Before experience is gained with Process RVNP, it is important to know generally what photographic effects can be expected as a result of variations and approximately what magnitude of change can produce a noticeable photographic effect. Such information is helpful in diagnosing the cause of a photographically off-balance condition. Some of the major photographic effects of mechanical and chemical variations on EASTMAN EKTACHROME Films are illustrated in Figures 14-2 through 14-14. Effects caused by contamination of the first developer and color developer are illustrated in Figures 14-15 through 14-22. Each plot shows the effect of a change in a process parameter (horizontal axis) on the dye density of the final film (vertical axis). The specifications for the various parameters are represented by the letter "S" along the horizontal axis. A plot at + 0.10 for the red density indicates the parameter change caused the red density to increase by 0.10 densitometric units above the process aim.

The magnitude of the changes shown in these plots **should not** be considered to be process-control limits. Also, the data presented are qualitative, not quantitative. The plots were derived from experiments using small laboratory machines in which all constituents were held constant except the variable being studied. Hence, the figures should be used only as trend charts and guides. If two or more process parameters are varied, the resulting photographic effect may not be additive. Interactions can occur that produce effects other than those predicted by addition. The plots in this publication are representative only; they do not contain all possible solution problems. Most of the important photographic effects take place in the developer. However, proper bleaching and fixing are also important.

Effects of Mechanical and Chemical Variations

Figure 14-2 Effects of Time, Temperature and pH Variations—7240 Film in Process RVNP First Developer

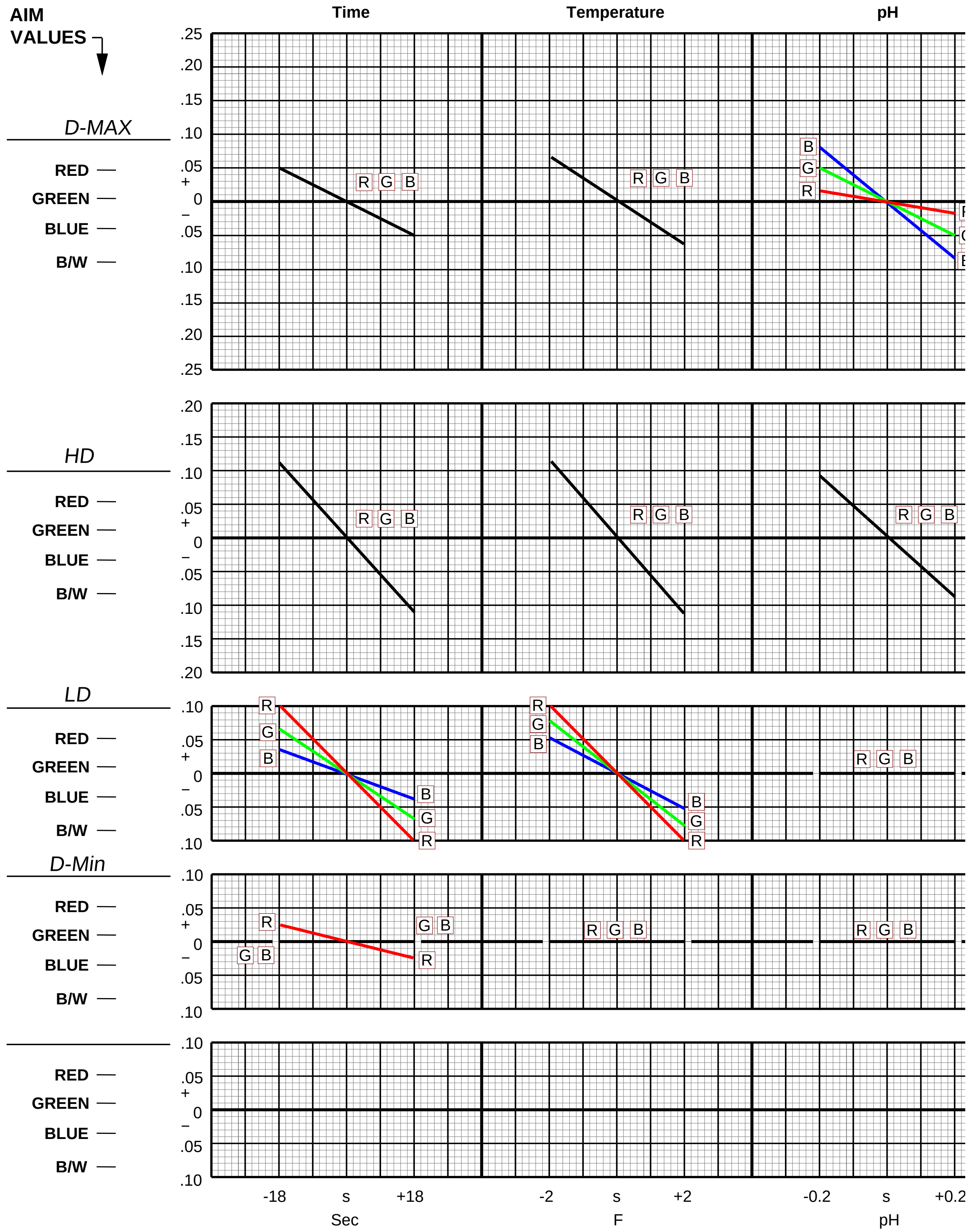

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Figure 14-3 Effects of Hydroquinone and Phenidone Variations—7240 Film in Process RVNP First Developer

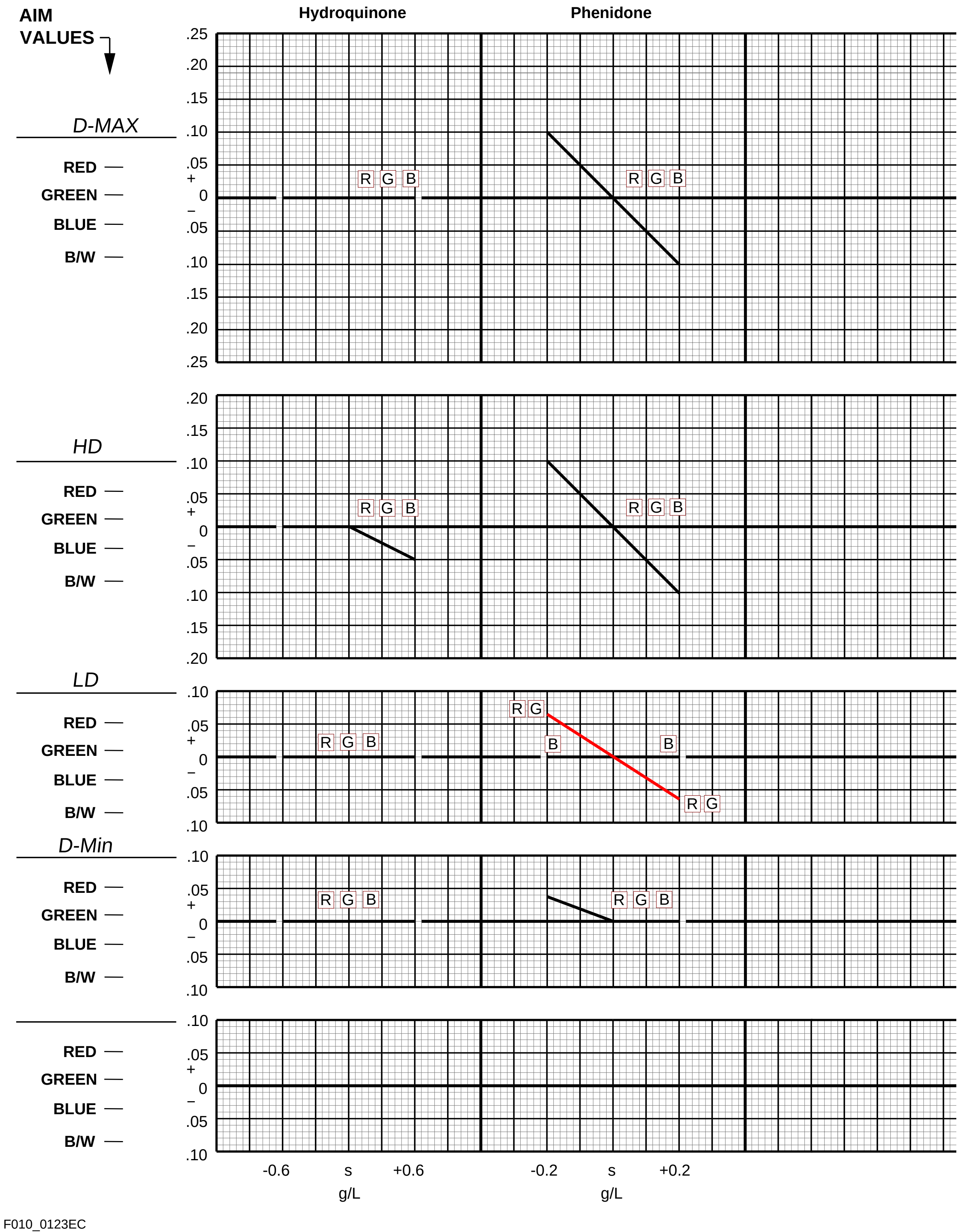

Figure 14-4 Effects of NaCNS and NaBr Variations—7240 Film in Process RVNP First Developer

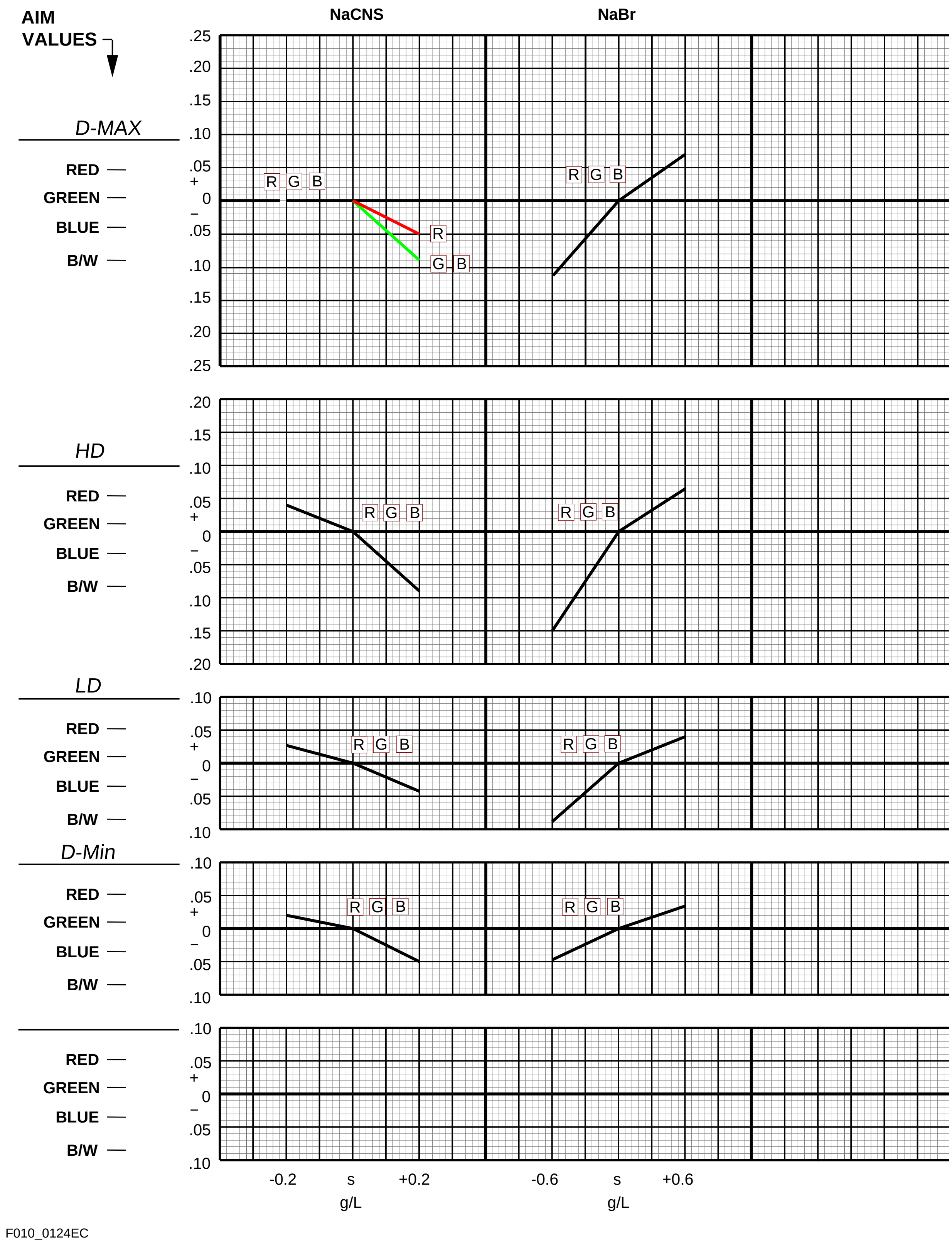

Figure 14-5 Effects of Time, Temperature and pH Variations—7240 Film in Process RVNP Color Developer

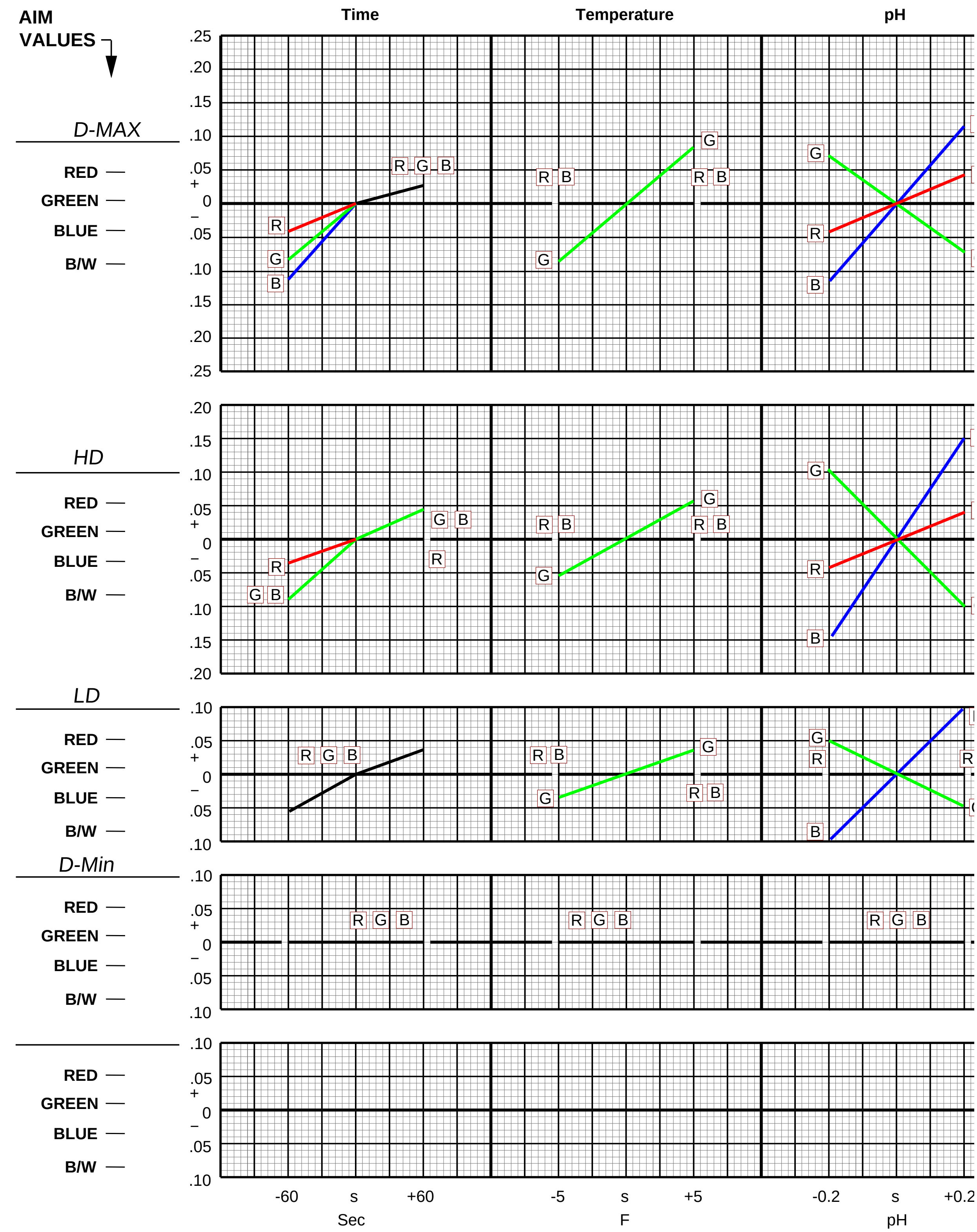

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Figure 14-6 Effects of CD-3, NaBr and RA-1 Variations—7240 Film in Process RVNP Color Developer

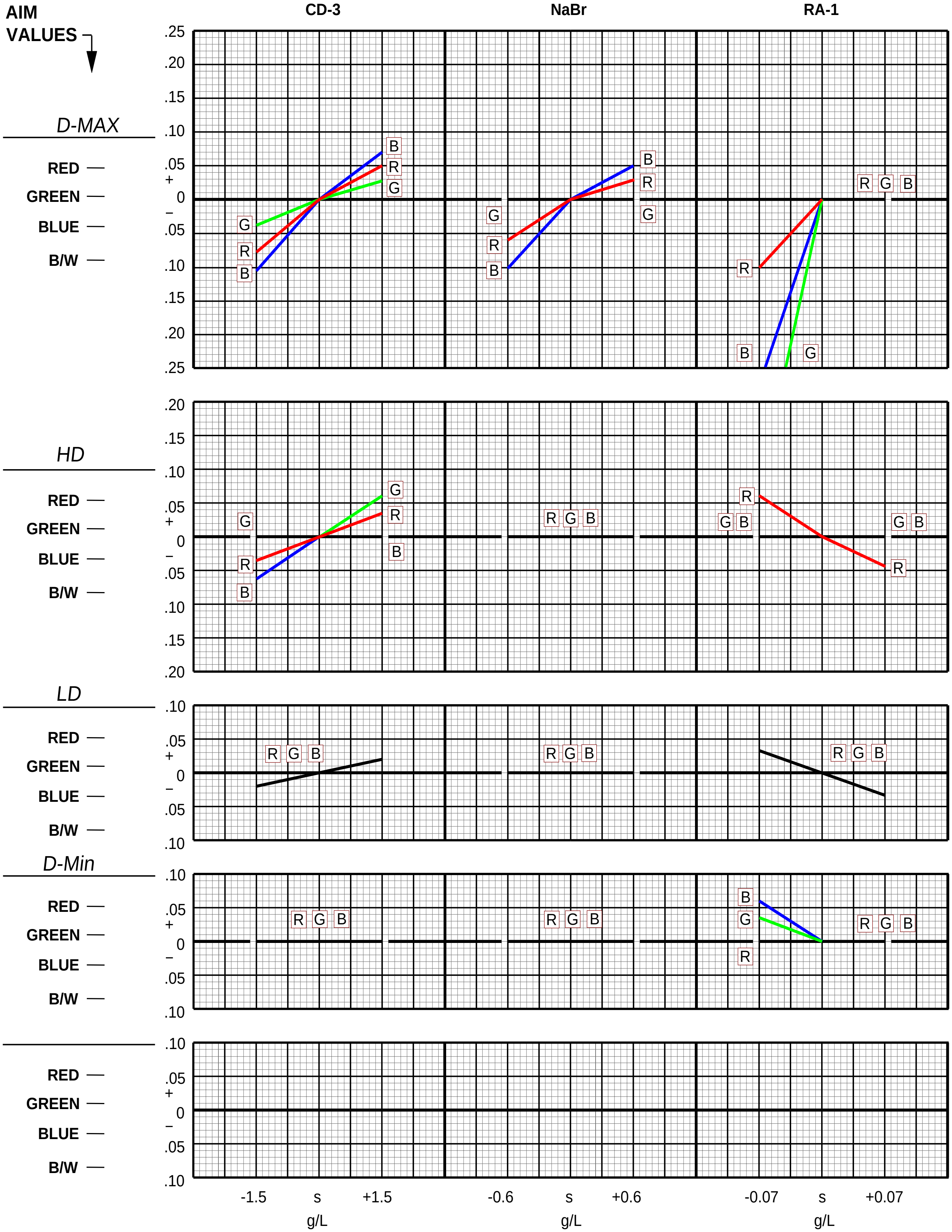

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Figure 14-7 Effects of Citrazinic Acid and Benzyl Alcohol Variations—7240 Film in Process RVNP Color Developer

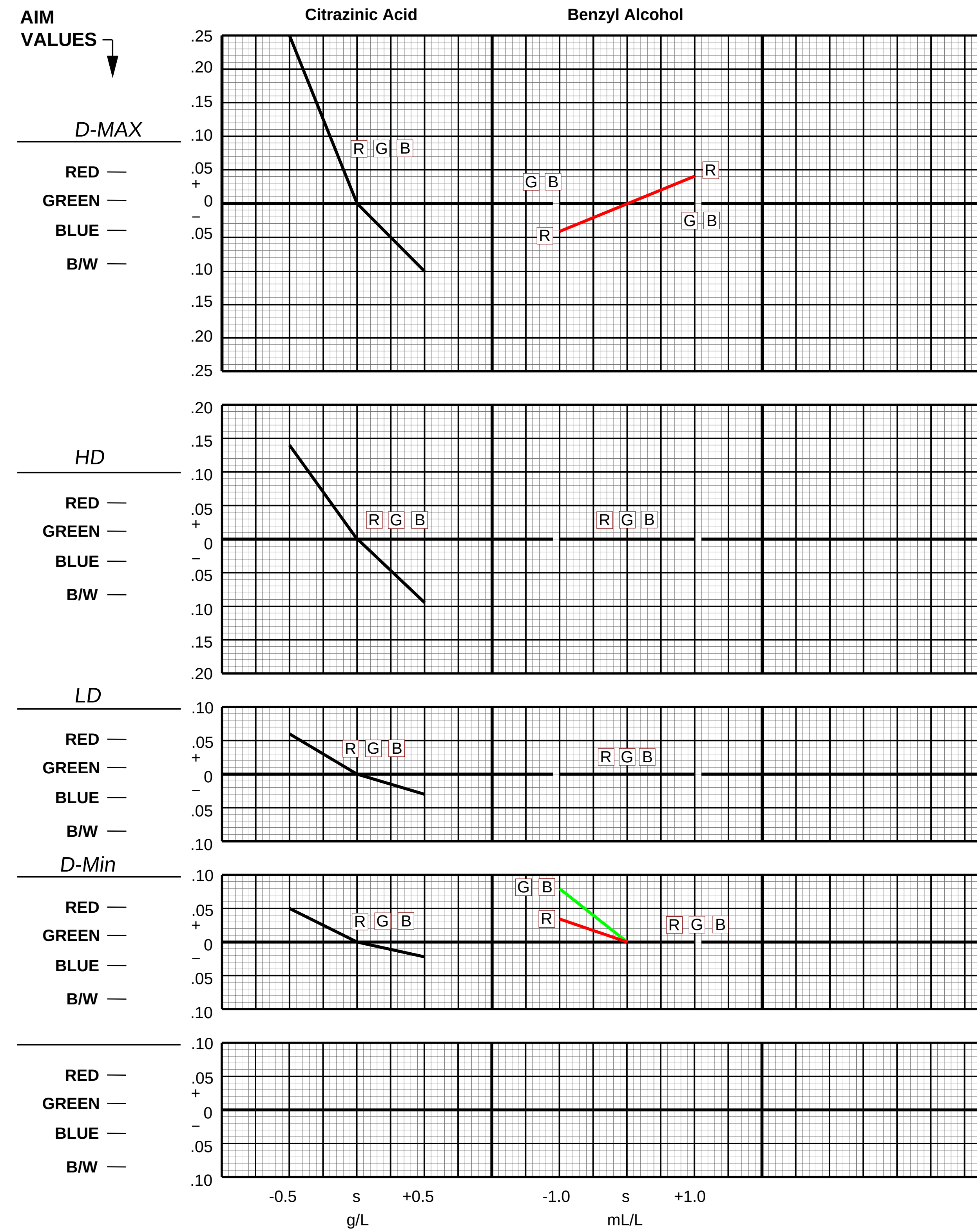

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Figure 14-8 Effects of Time, Temperature and pH Variations—7399 Film in Process RVNP First Developer

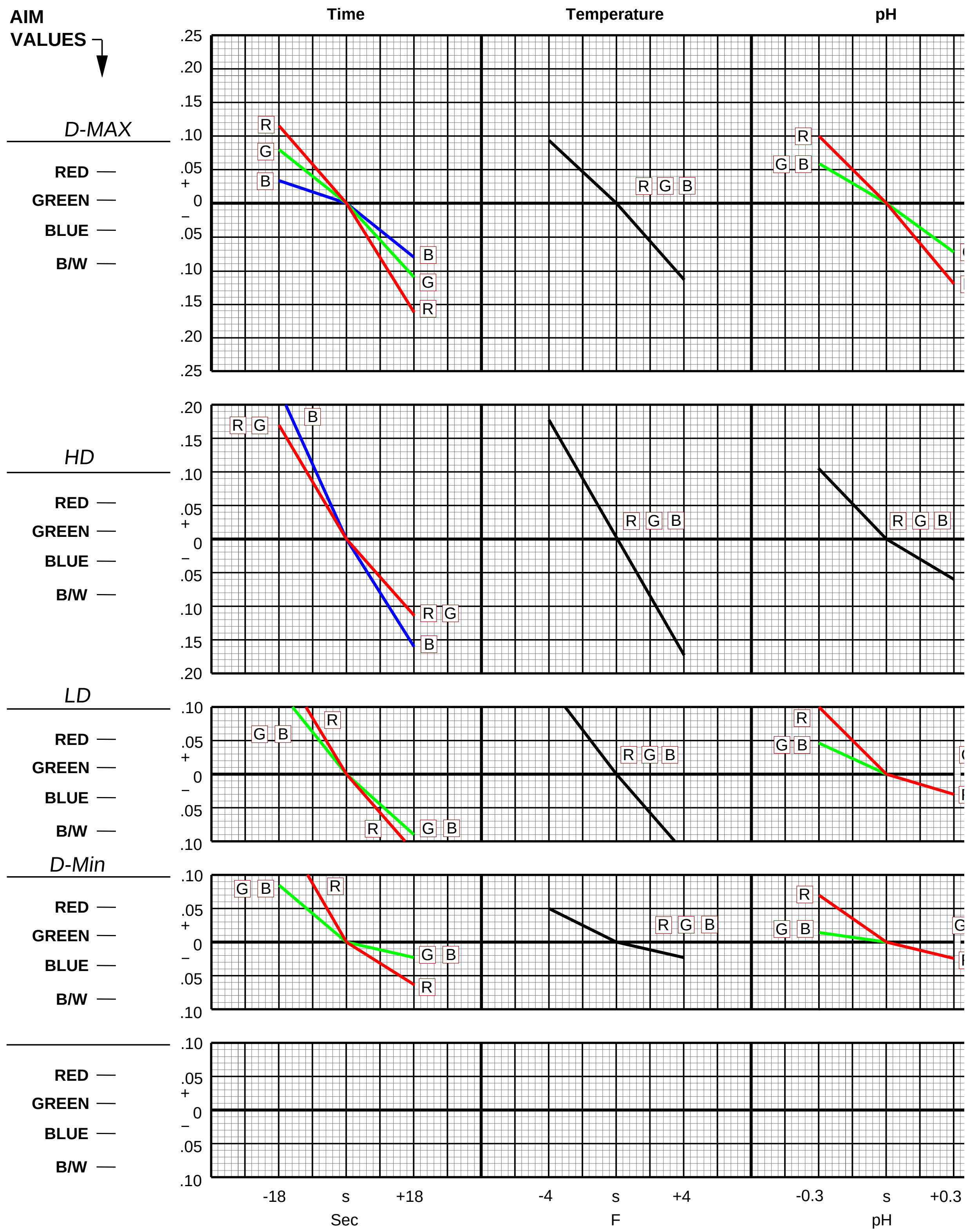

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Figure 14-9 Effects of Phenidone, Na_2SO_3 and Hydroquinone Variations—7399 Film in Process RVNP First Developer

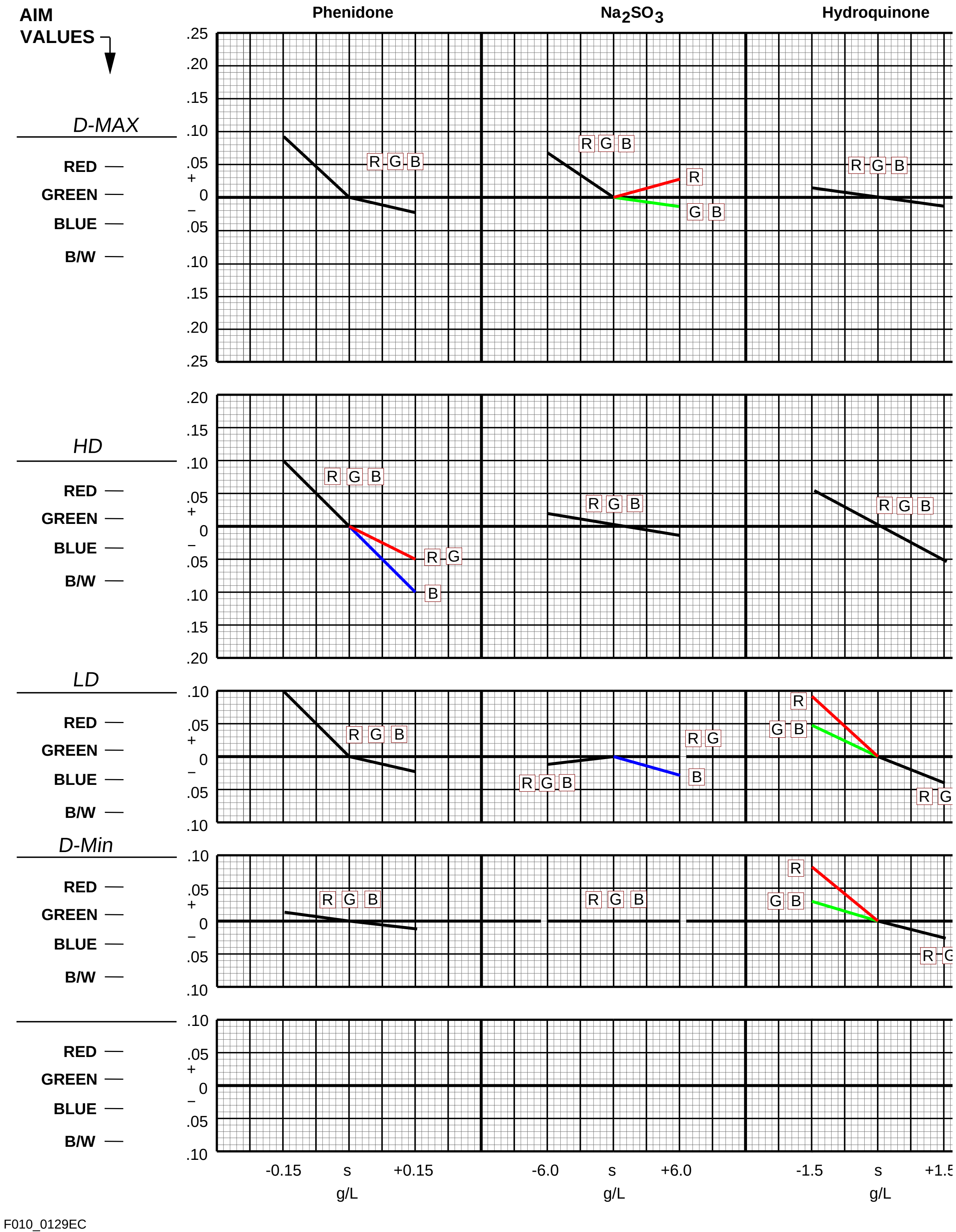

Figure 14-10 Effects of NaCNS, NaBr and KI Variations—7399 Film in Process RVNP First Developer

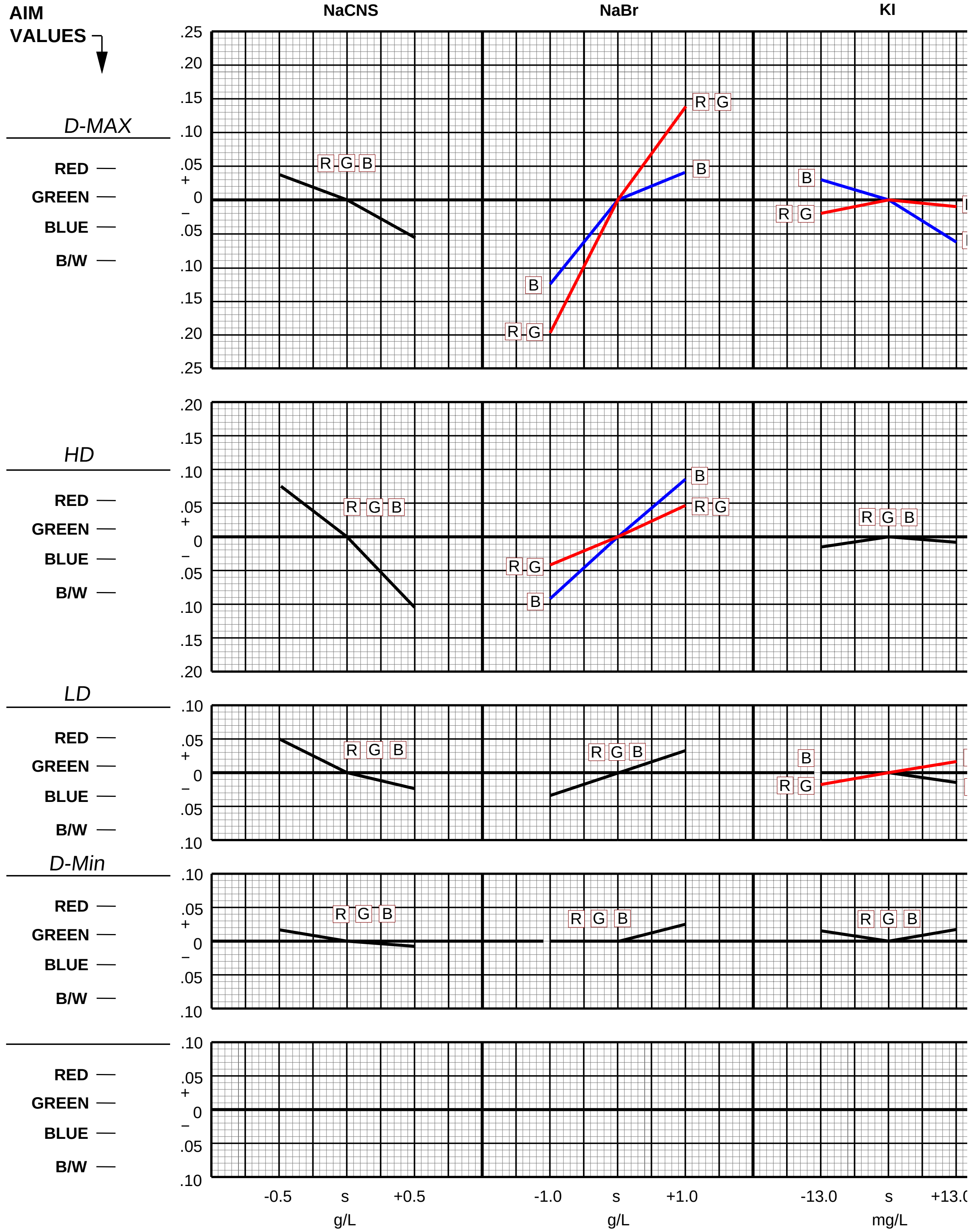

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Figure 14-11 Effects of Time, Temperature and pH Variations—7399 Film in Process RVNP Color Developer

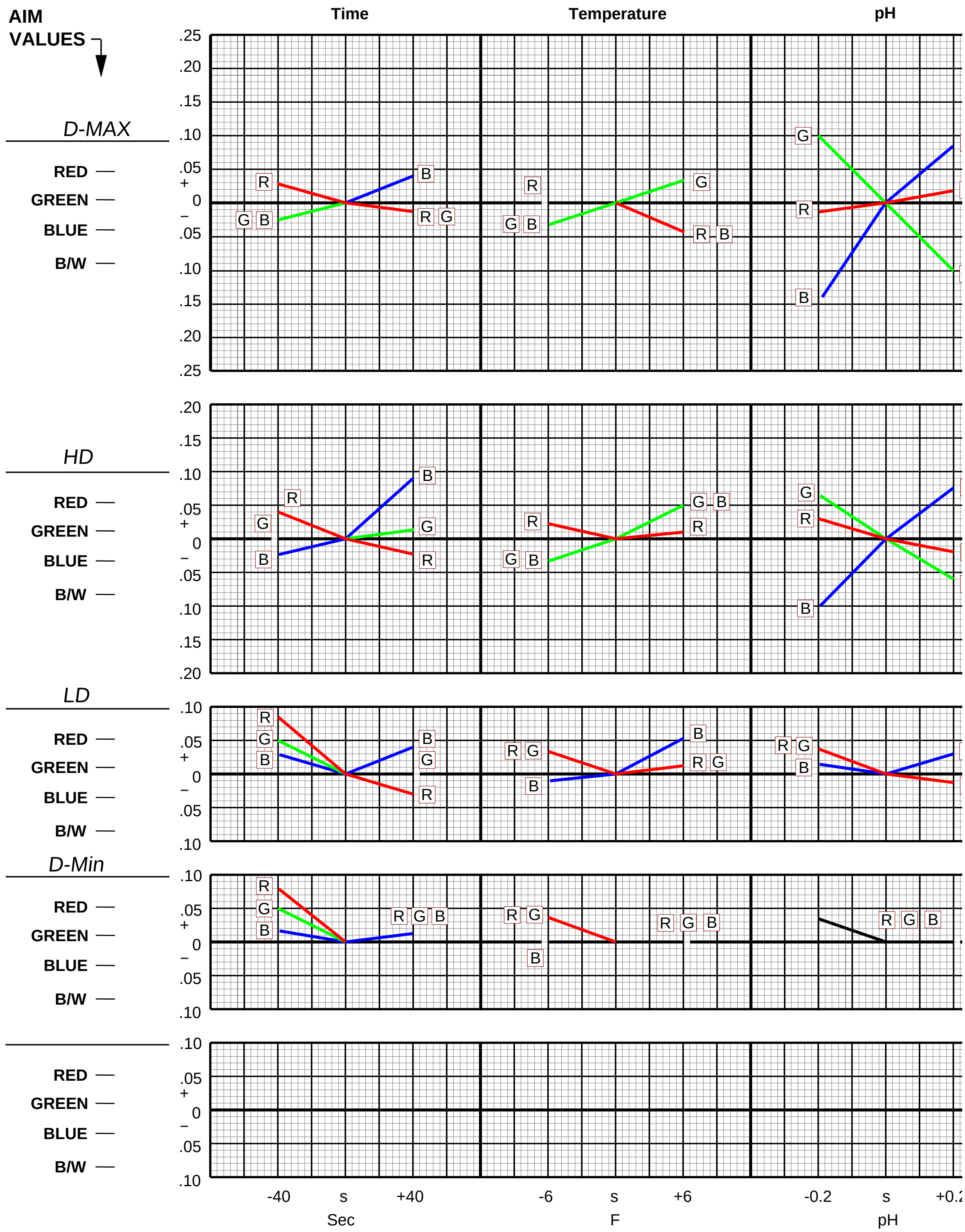

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Figure 14-12 Effects of Benzyl Alcohol, Na_2SO_3 and NaBr Variations—7399 Film in Process RVNP Color Developer

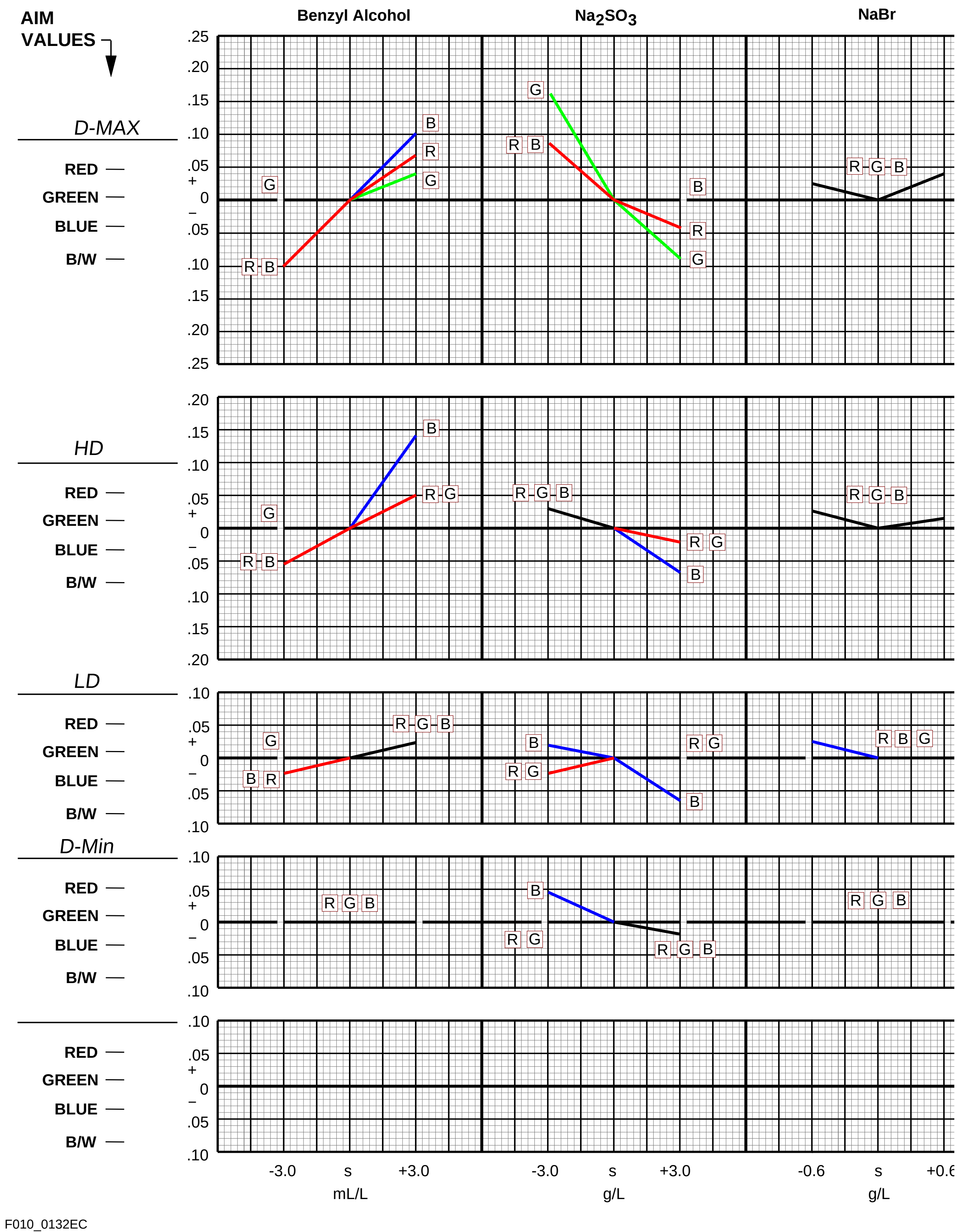


Figure 14-13 Effects of KI, Citrazinic Acid and CD-3 Variations—7399 Film in Process RVNP Color Developer

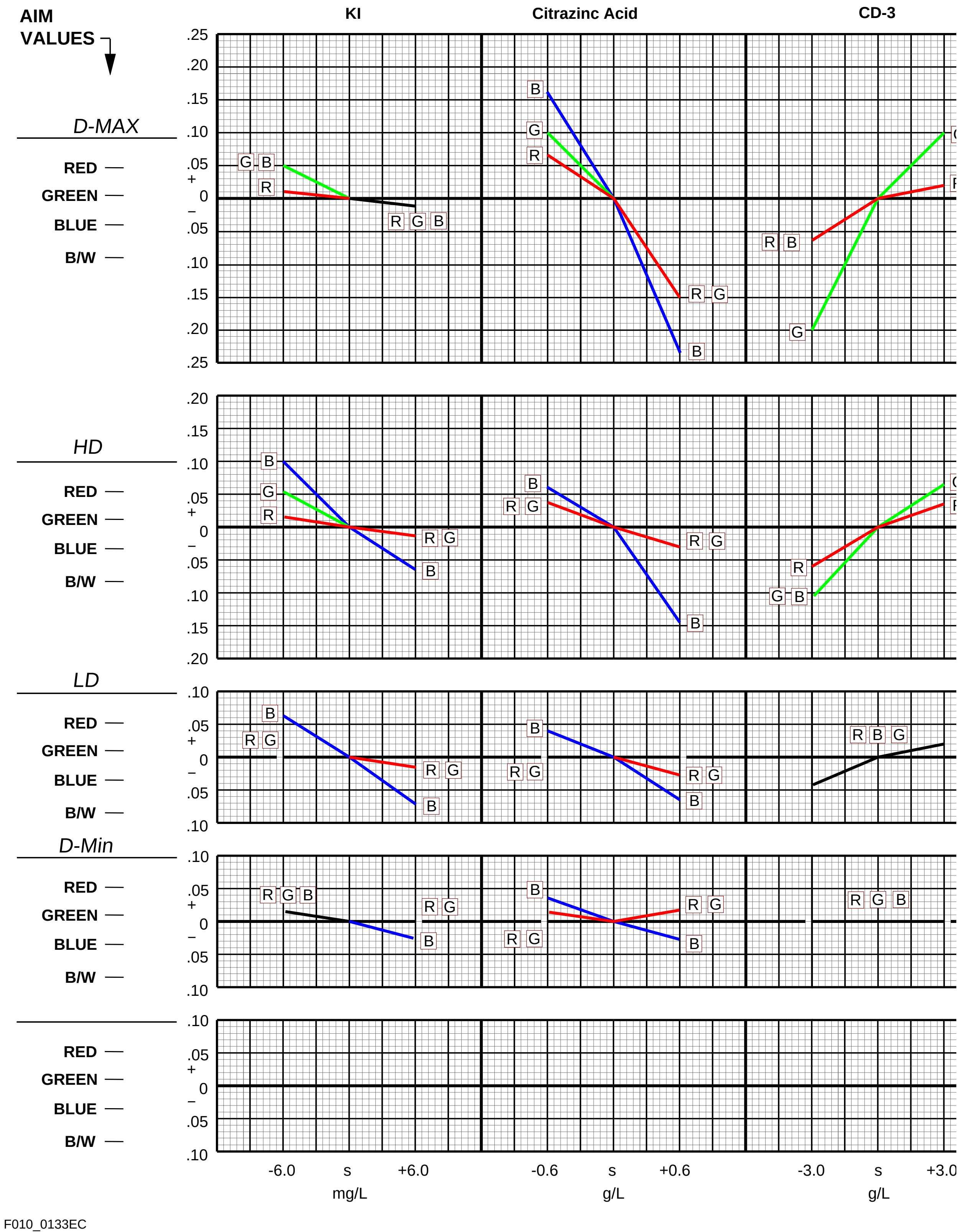
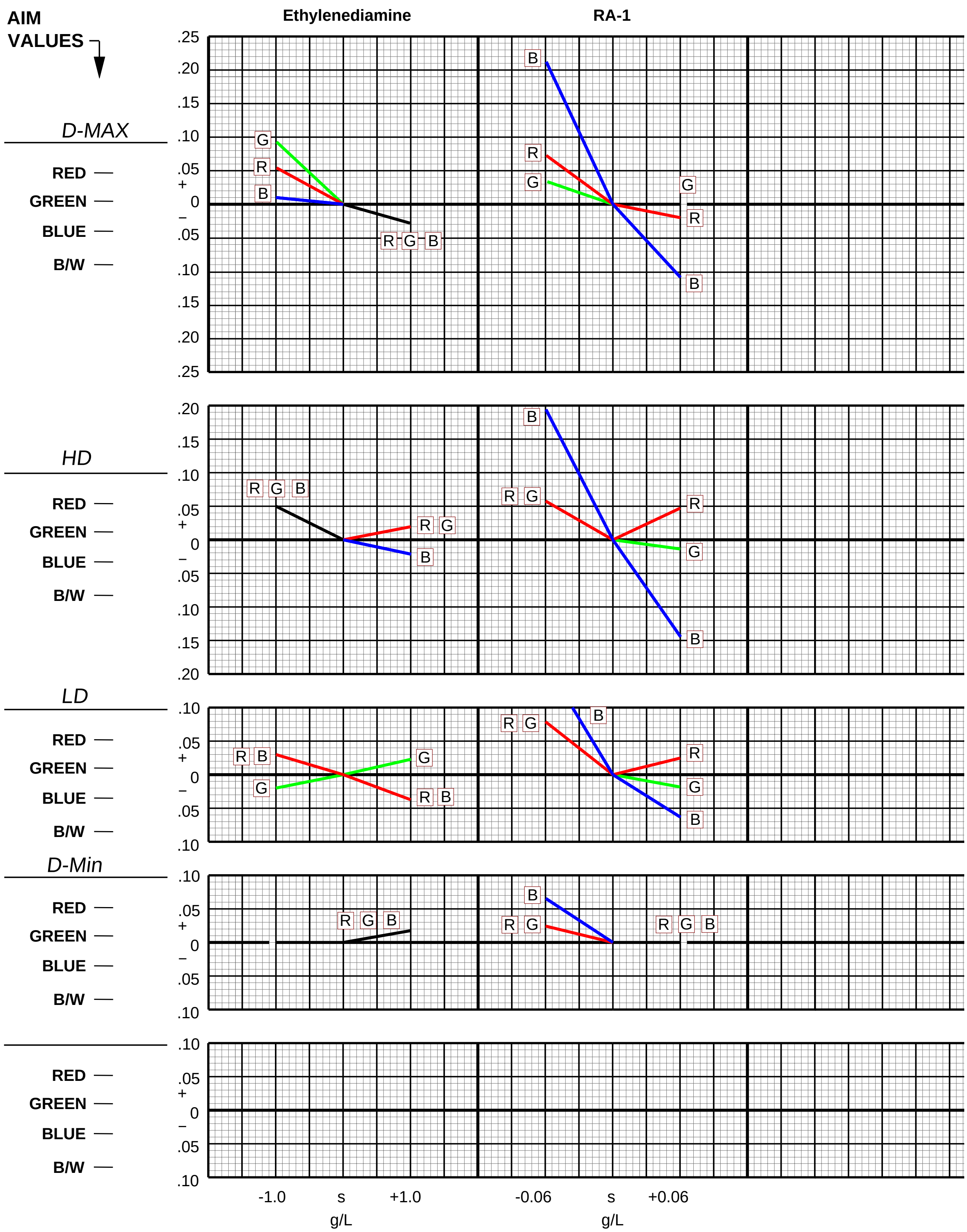


Figure 14-14 Effects of Ethylenediamine and RA-1 Variations—7399 Film in Process RVNP Color Developer



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Effects of Contamination

Figure 14-15 Effects of Color Developer and Fixer Contamination—7240 Film in Process RVNP First Developer

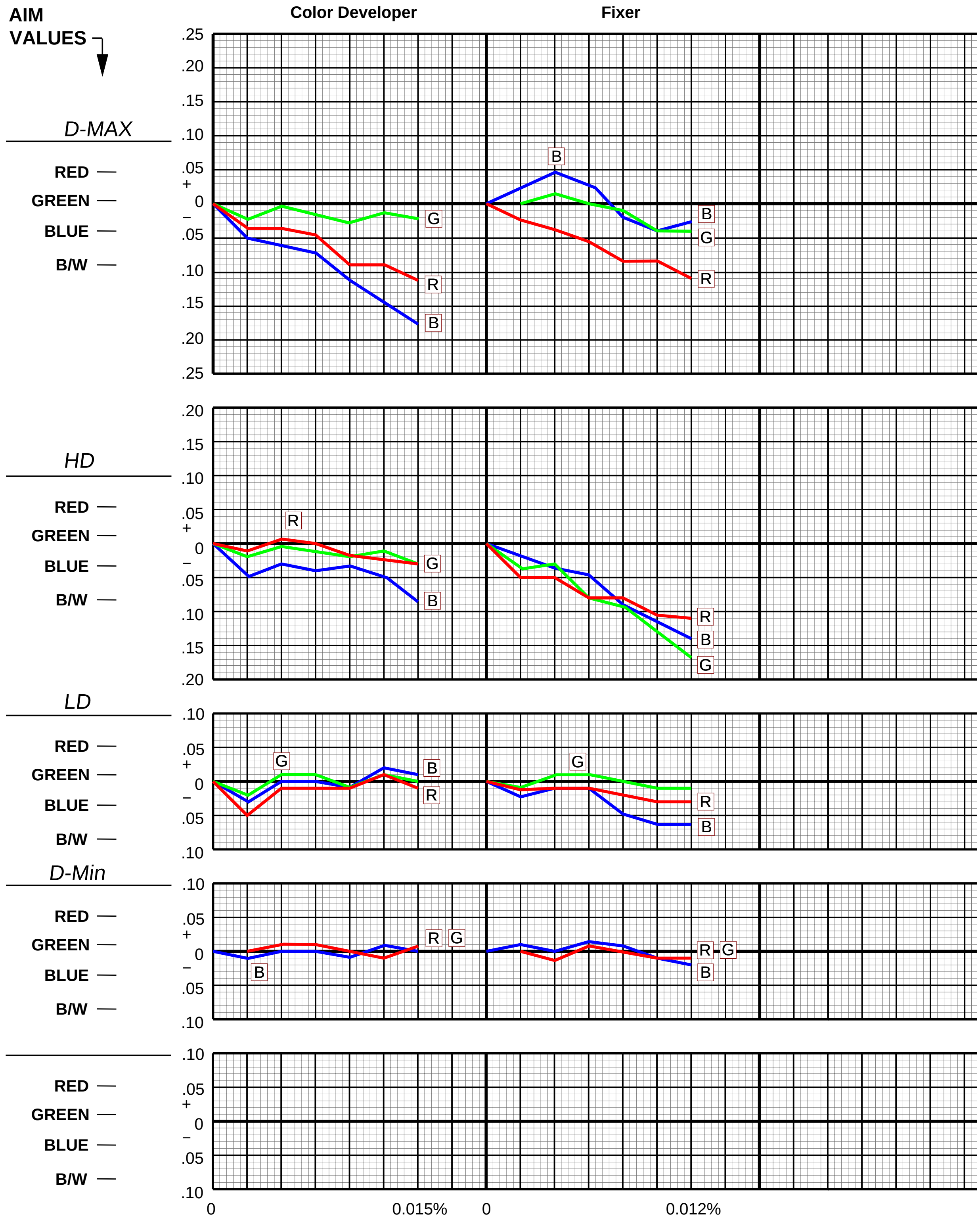

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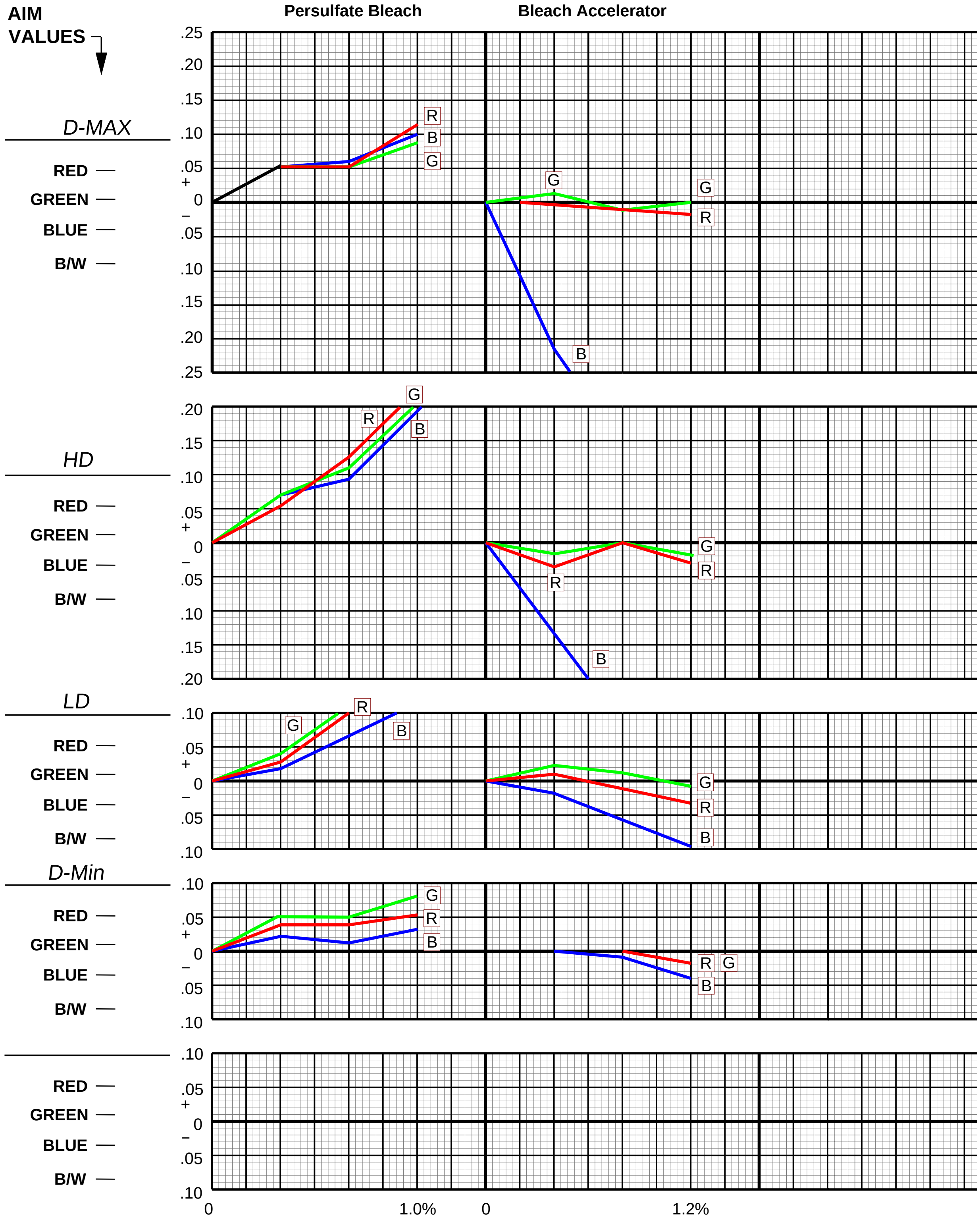
Figure 14-16 Effects of Persulfate Bleach and Bleach Accelerator Contamination —7240 Film in Process RVNP First Developer



F010_0136EC

Figure 14-17 Effects of First Developer and Fixer Contamination—7240 Film in Process RVNP Color Developer

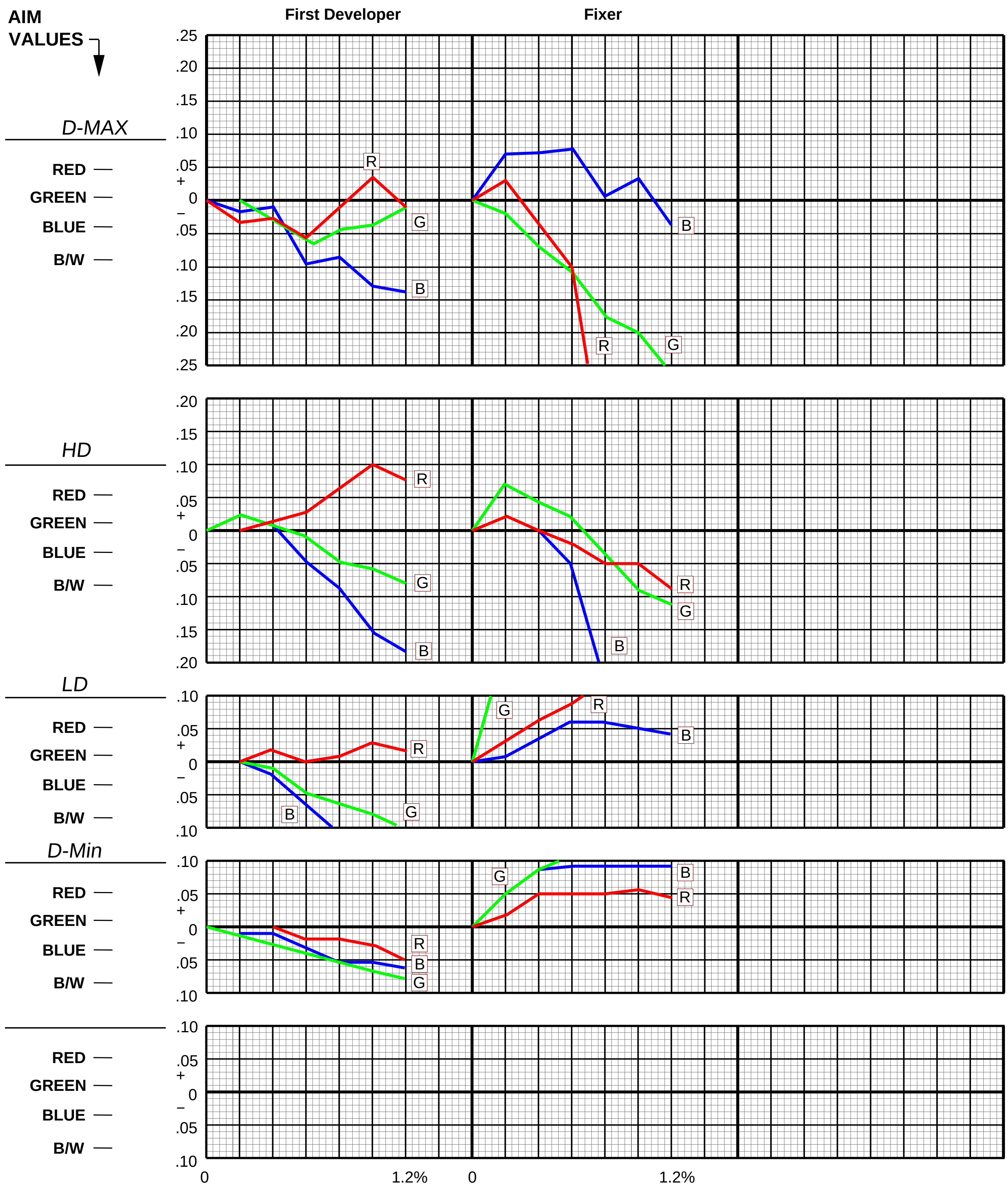


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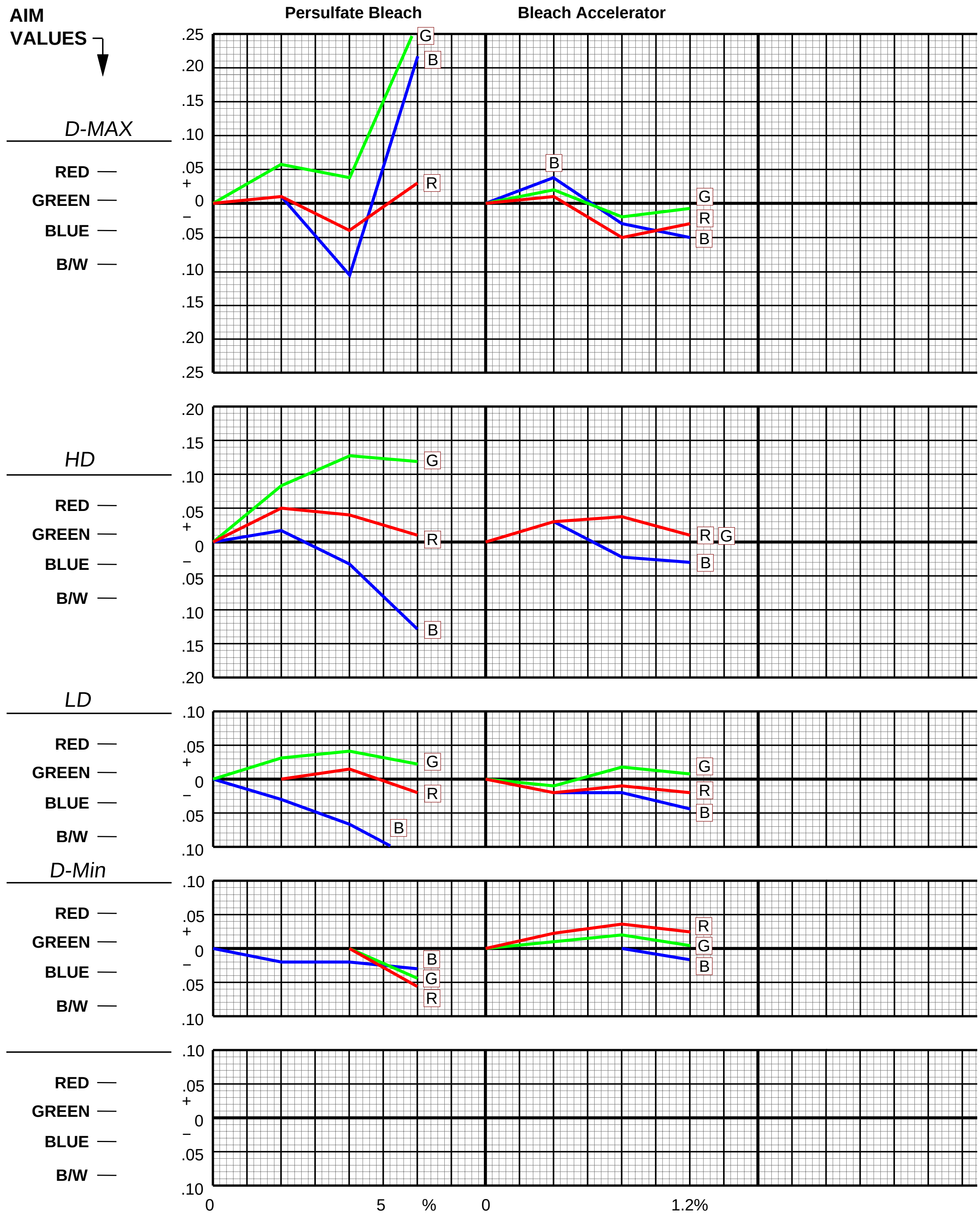
Figure 14-18 Effects of Persulfate Bleach and Bleach Accelerator Contamination
—7240 Film in Process RVNP Color Developer



F010_0138EC

Figure 14-19 Effects of Color Developer and Fixer Contamination—7399 Film in Process RVNP First Developer

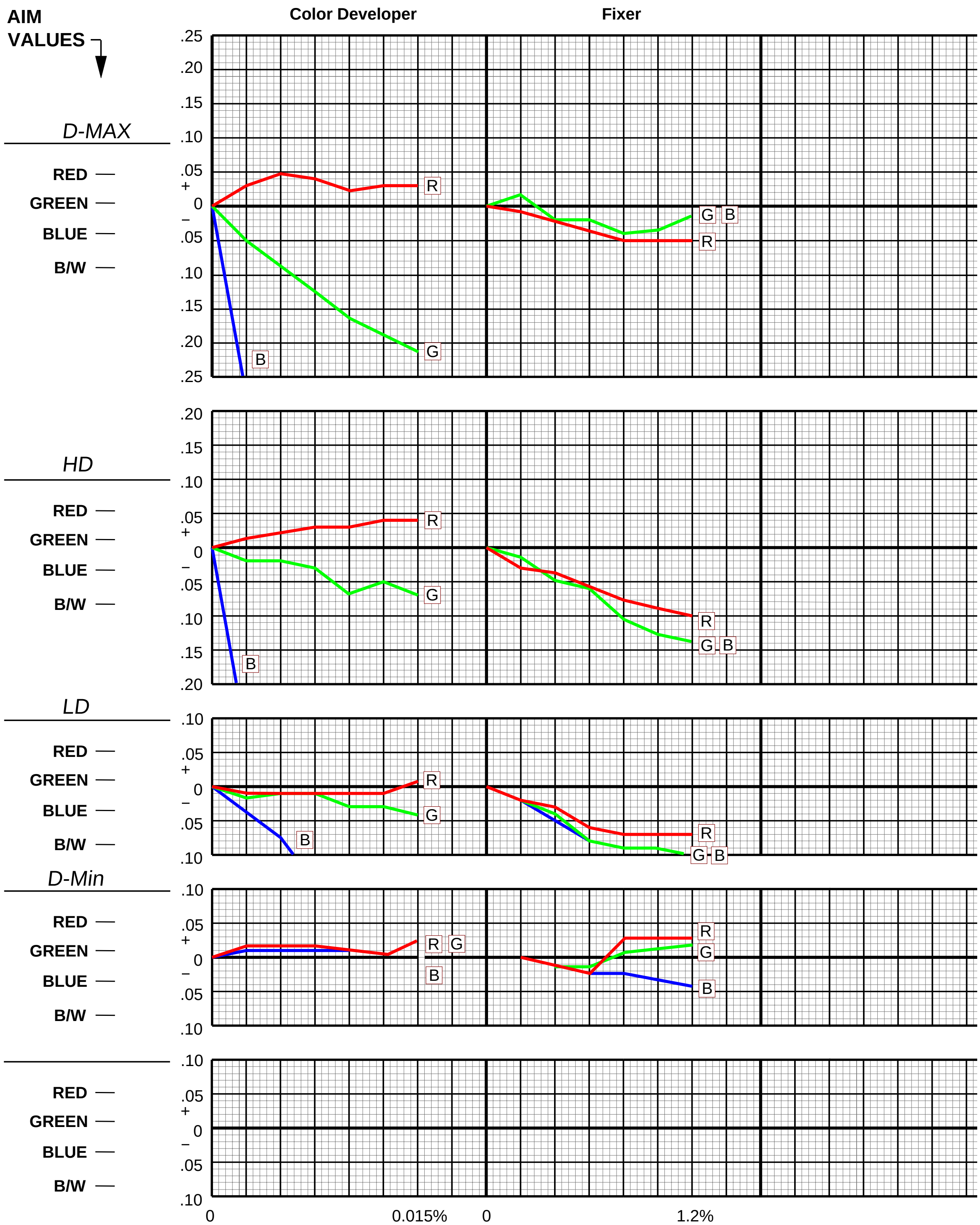


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Figure 14-20 Effects of Persulfate Bleach and Bleach Accelerator Contamination
—7399 Film in Process RVNP First Developer

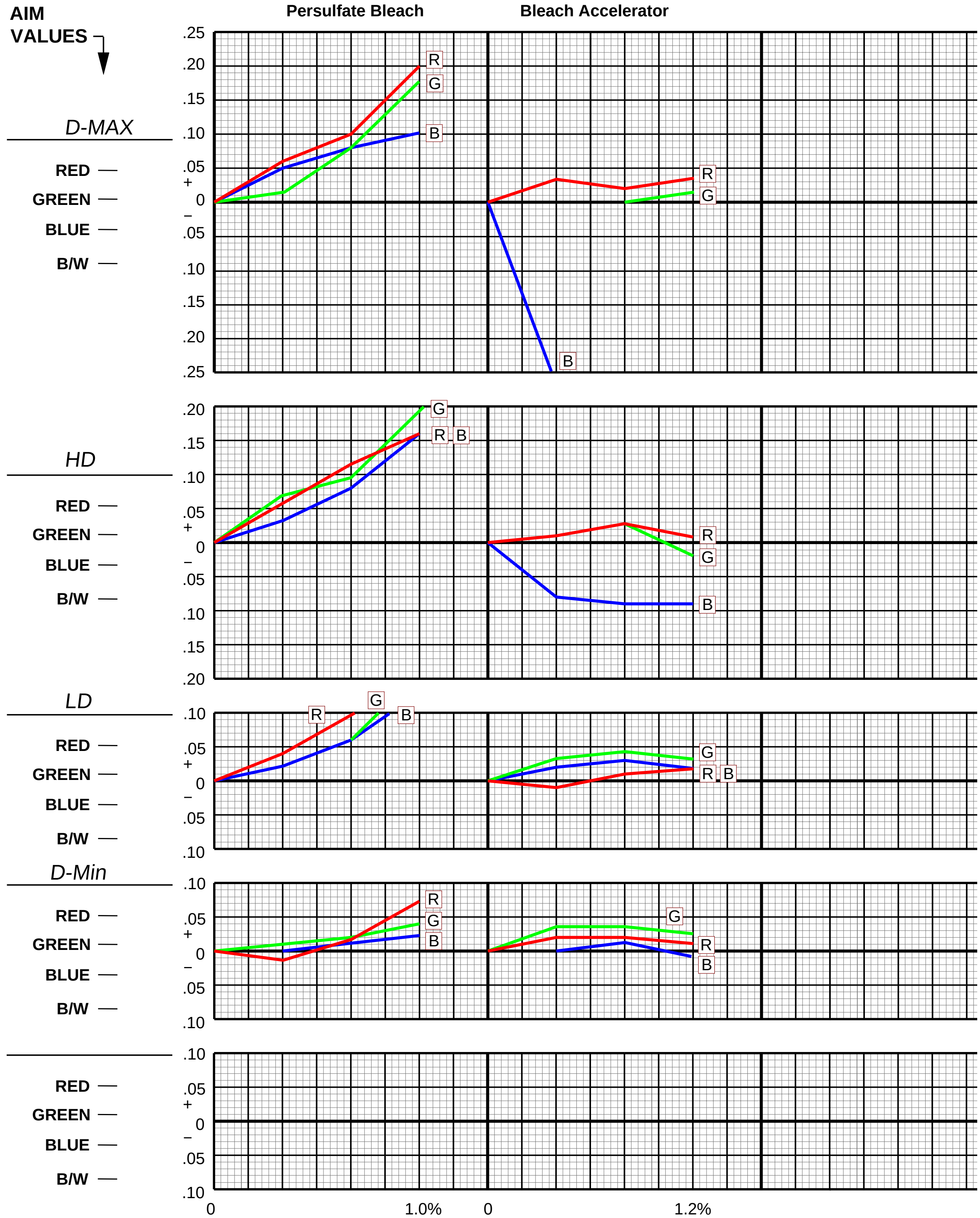

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Figure 14-21 Effects of First Developer and Fixer Contamination—7399 Film in Process RVNP Color Developer

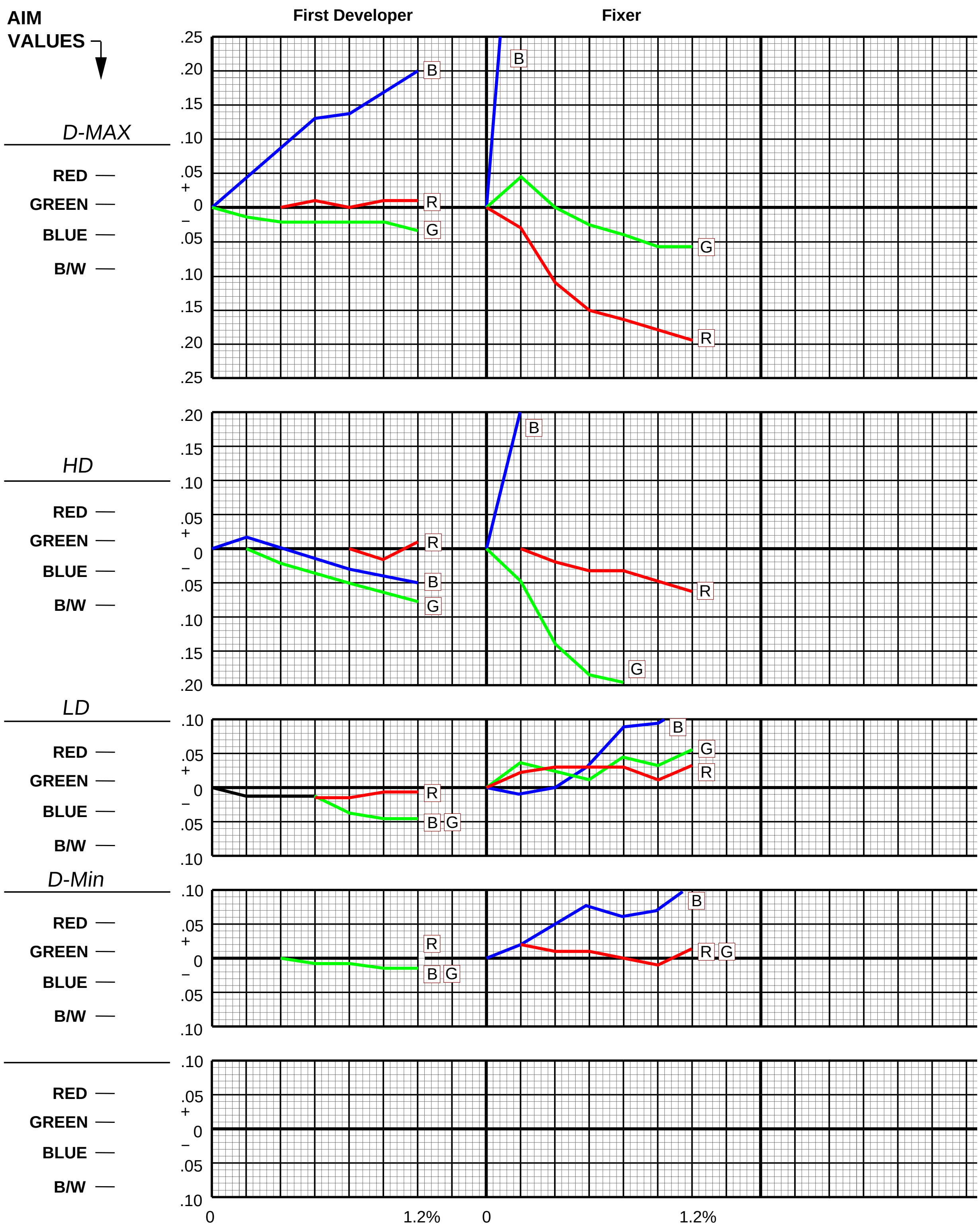

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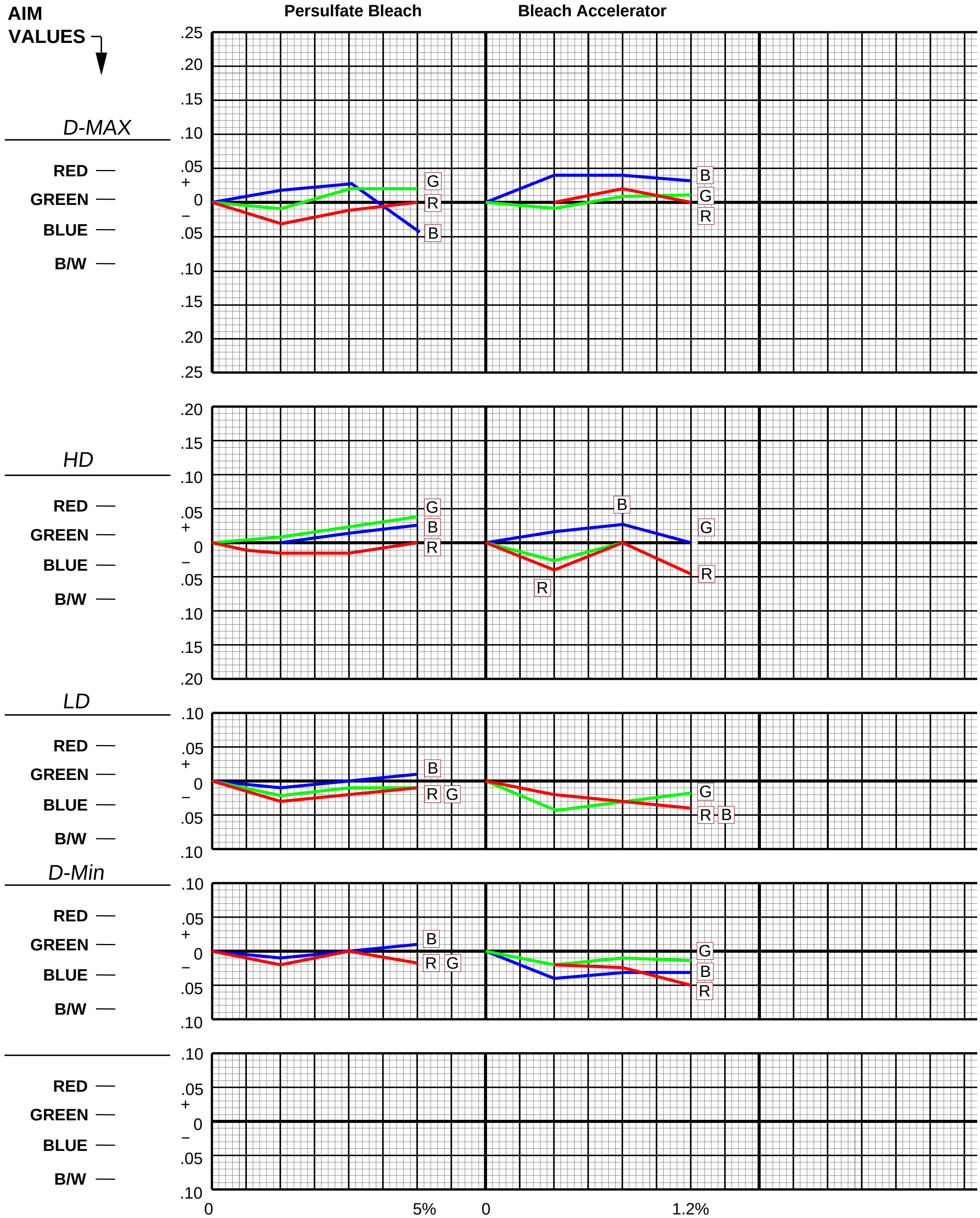
Figure 14-22 Effects of Persulfate Bleach and Bleach Accelerator Contamination
—7399 Film in Process RVNP Color Developer



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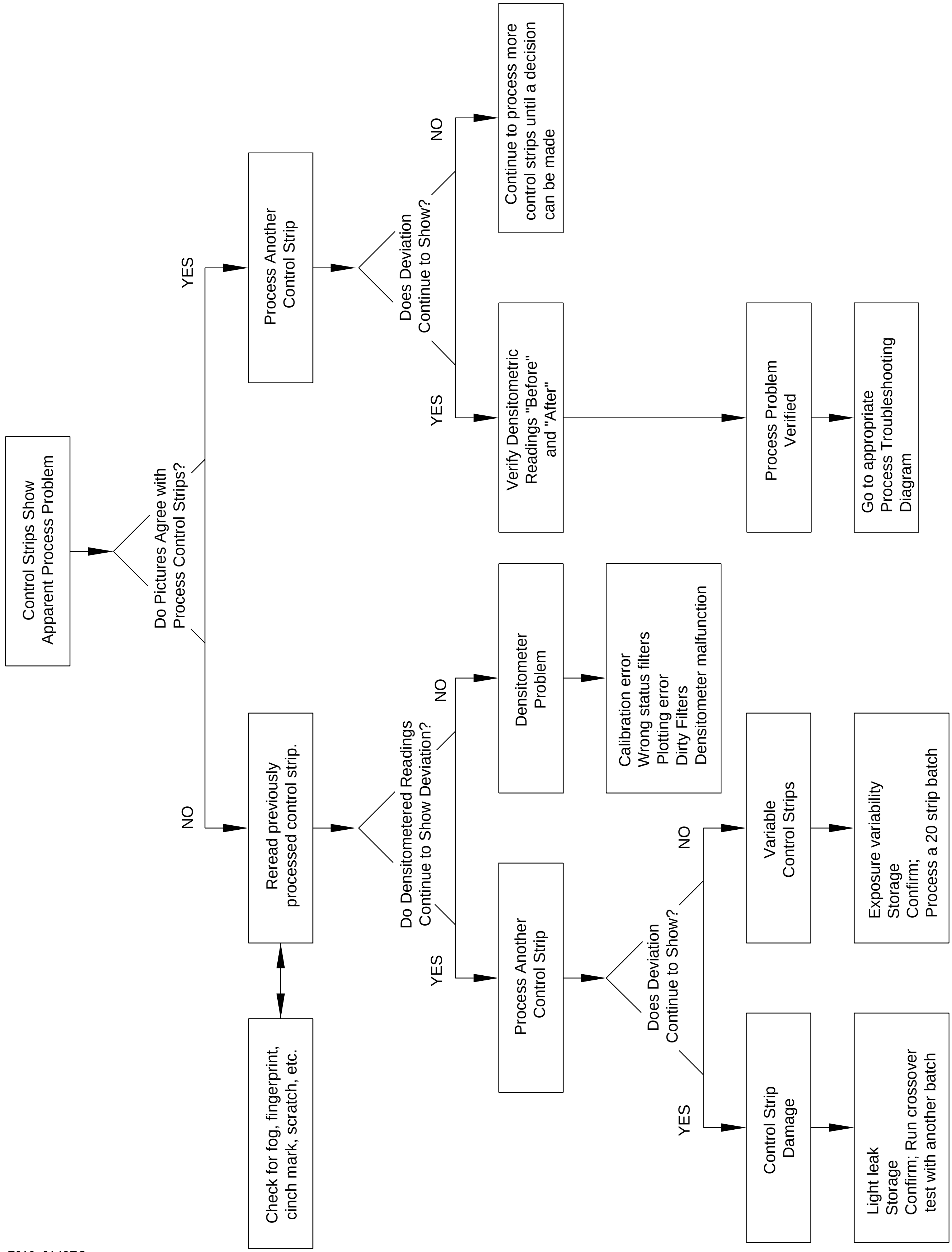
DIAGNOSTIC SCHEMES

The flow chart procedures illustrated in Figures 14-23 to 14-30 will aid in determining the source of an out-of-control situation. There are nine major schemes:

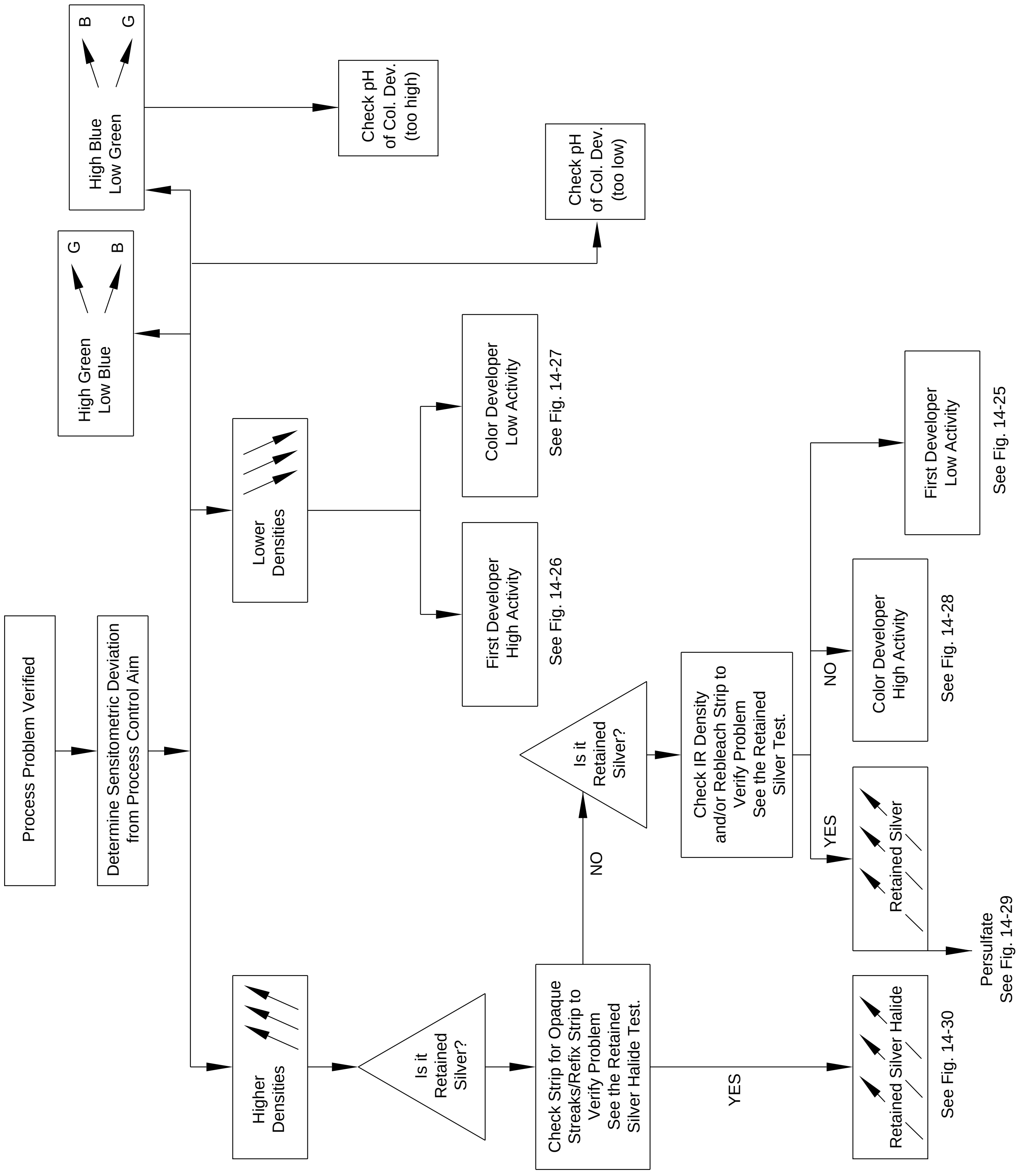
- *Verification Process*, Figure 14-23
- *Problem Sorting*, Figure 14-24
- *Low First Developer Activity*, Figure 14-25
- *High First Developer Activity*, Figure 14-26
- *Low Color Developer Activity*, Figure 14-27
- *High Color Developer Activity*, Figure 14-28
- *Retained Silver in Persulfate Bleach*, Figure 14-29
- *Retained Silver Halide*, Figure 14-30

Figure 14-23 Verification Process



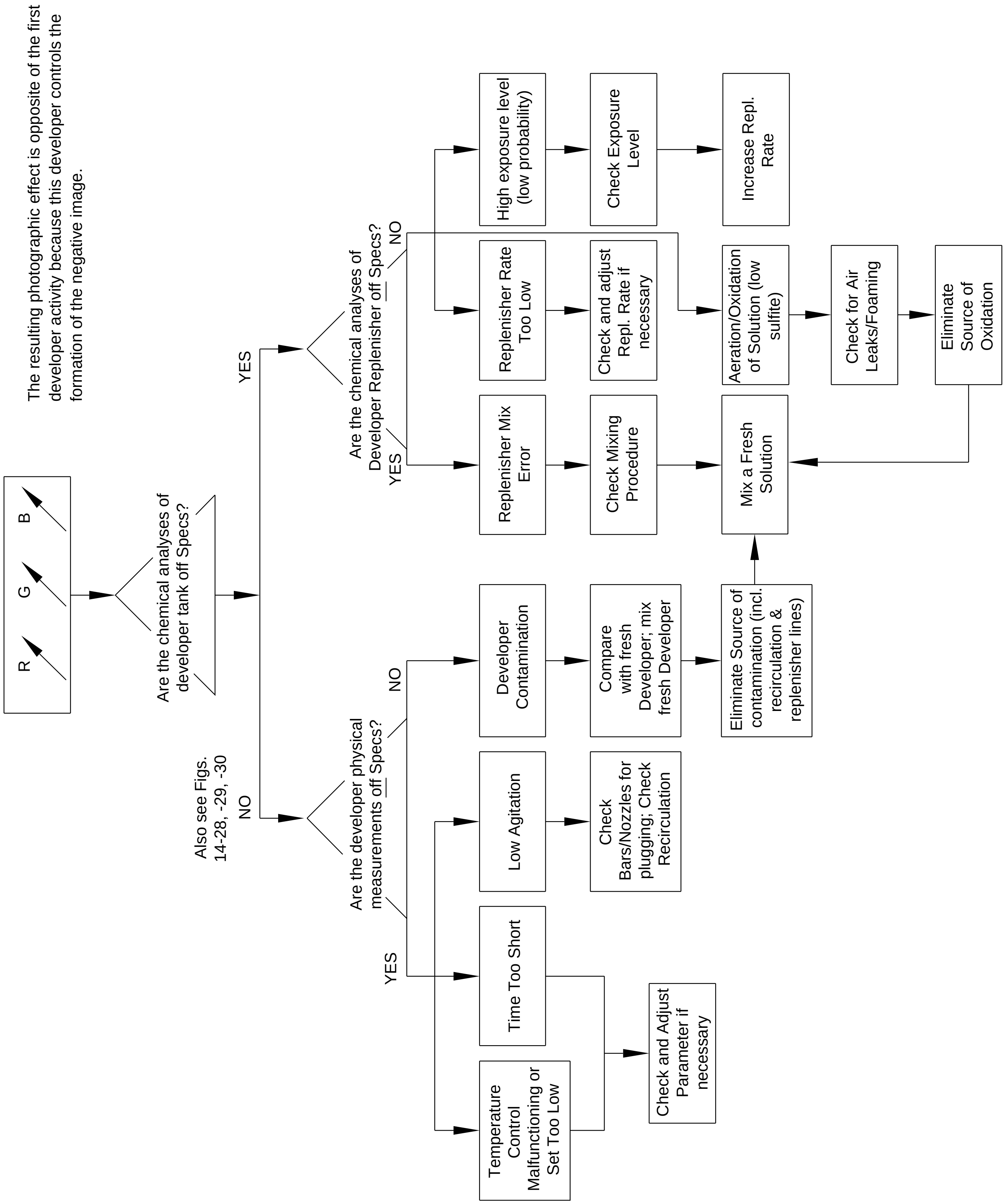
F010_0143EC

Figure 14-24 Problem Sorting



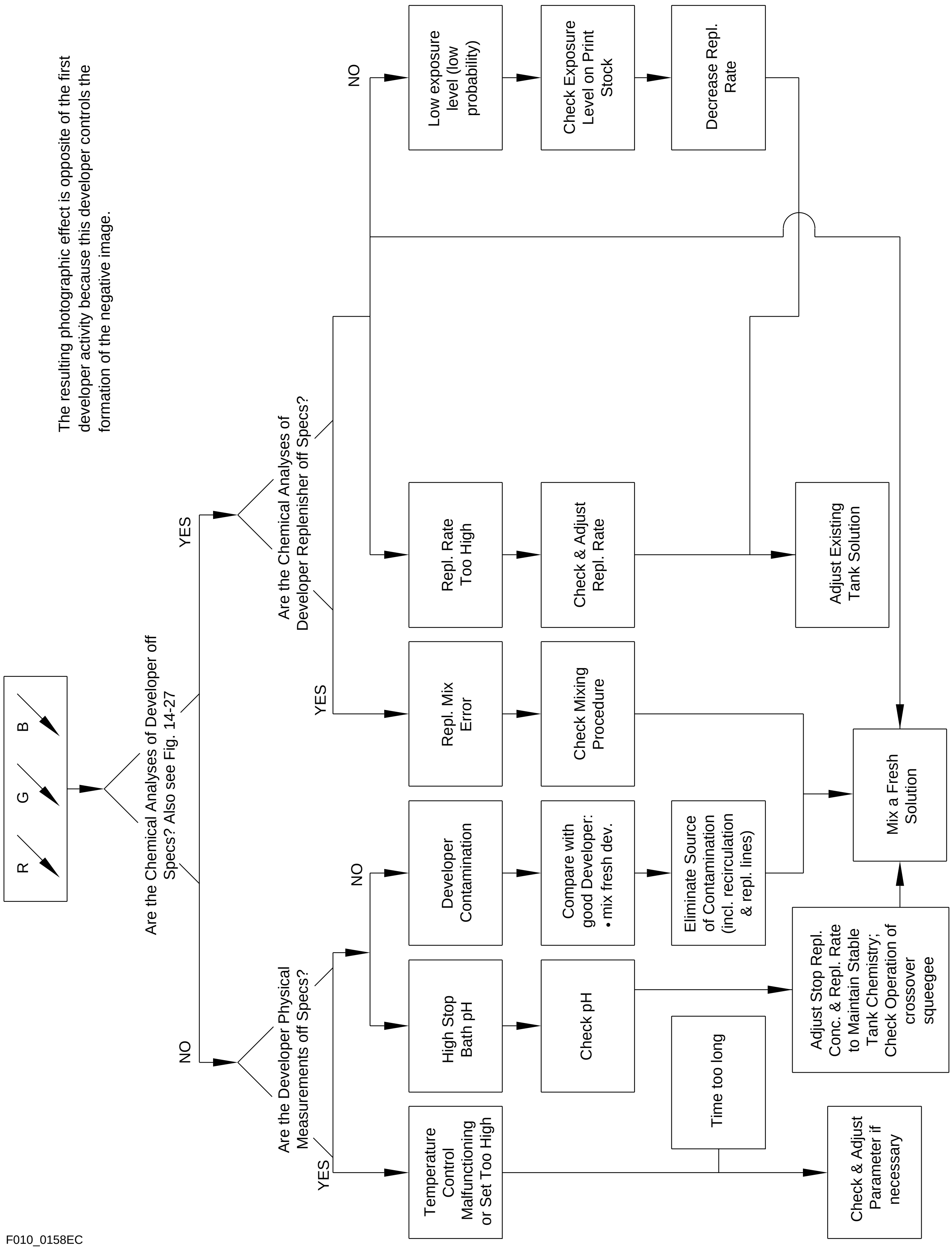
F010_0156EC

Figure 14-25 Low First Developer Activity



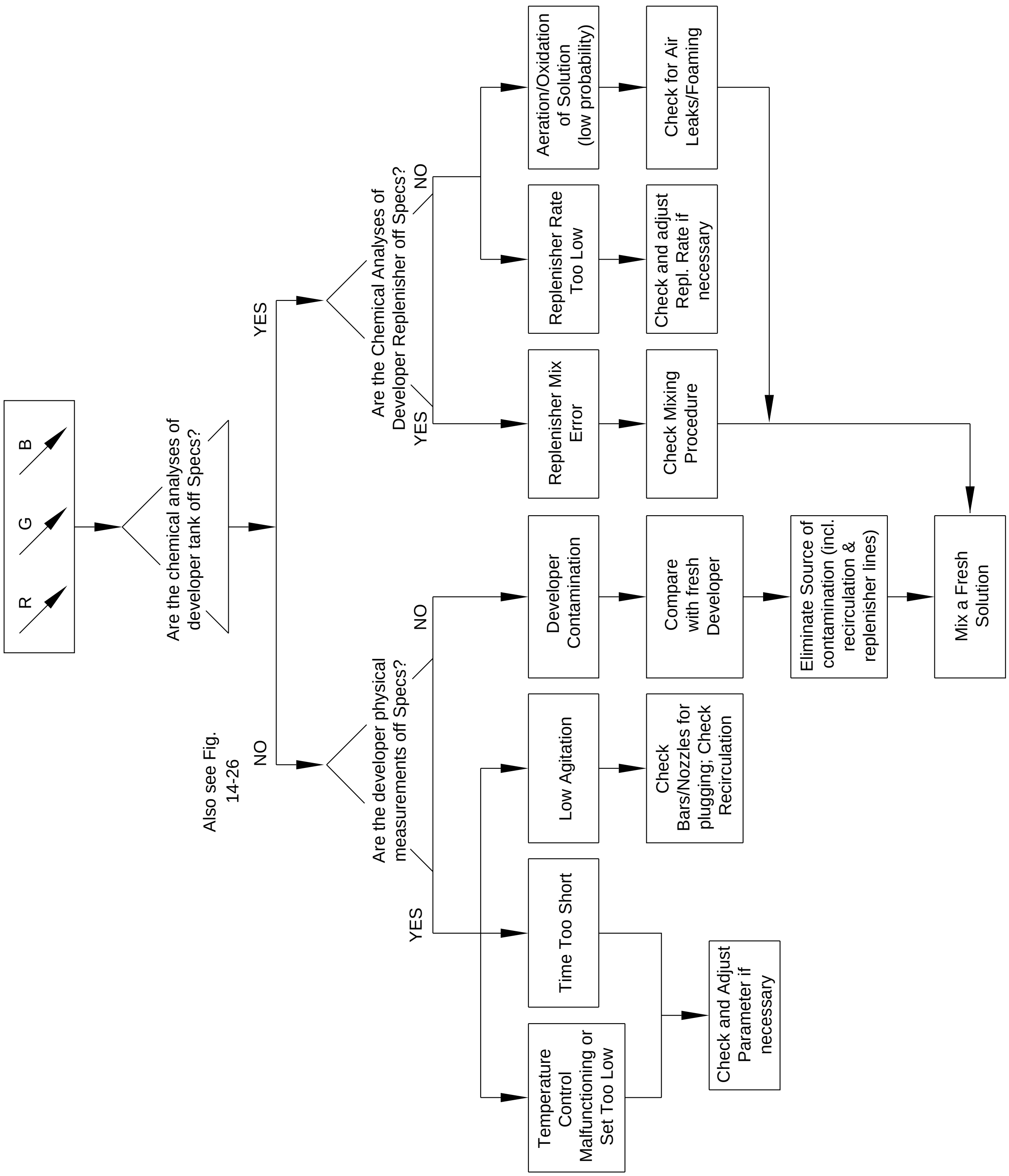
F010_0157EC

Figure 14-26 High First Developer Activity



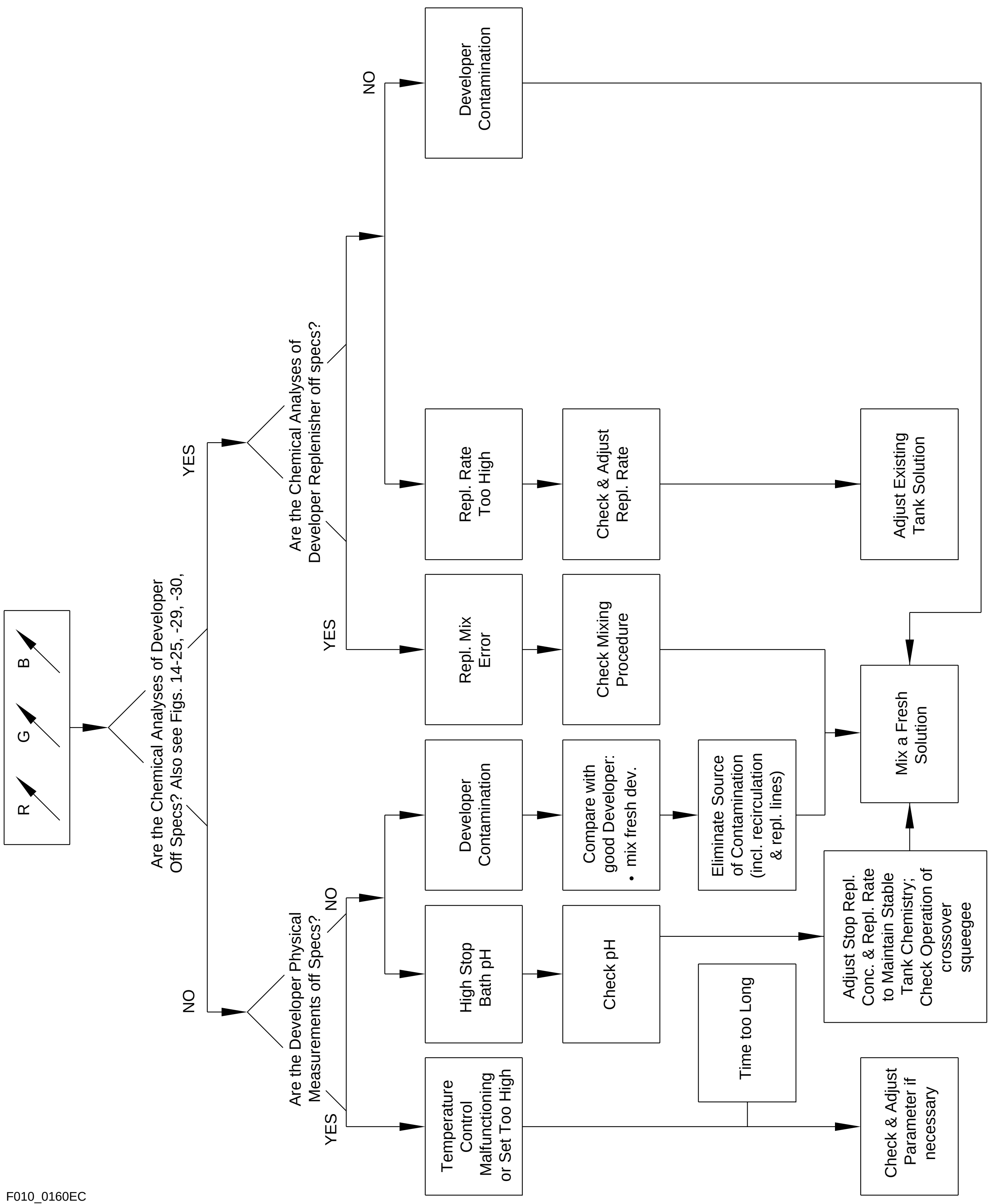
F010_0158EC

Figure 14-27 Low Color Developer Activity



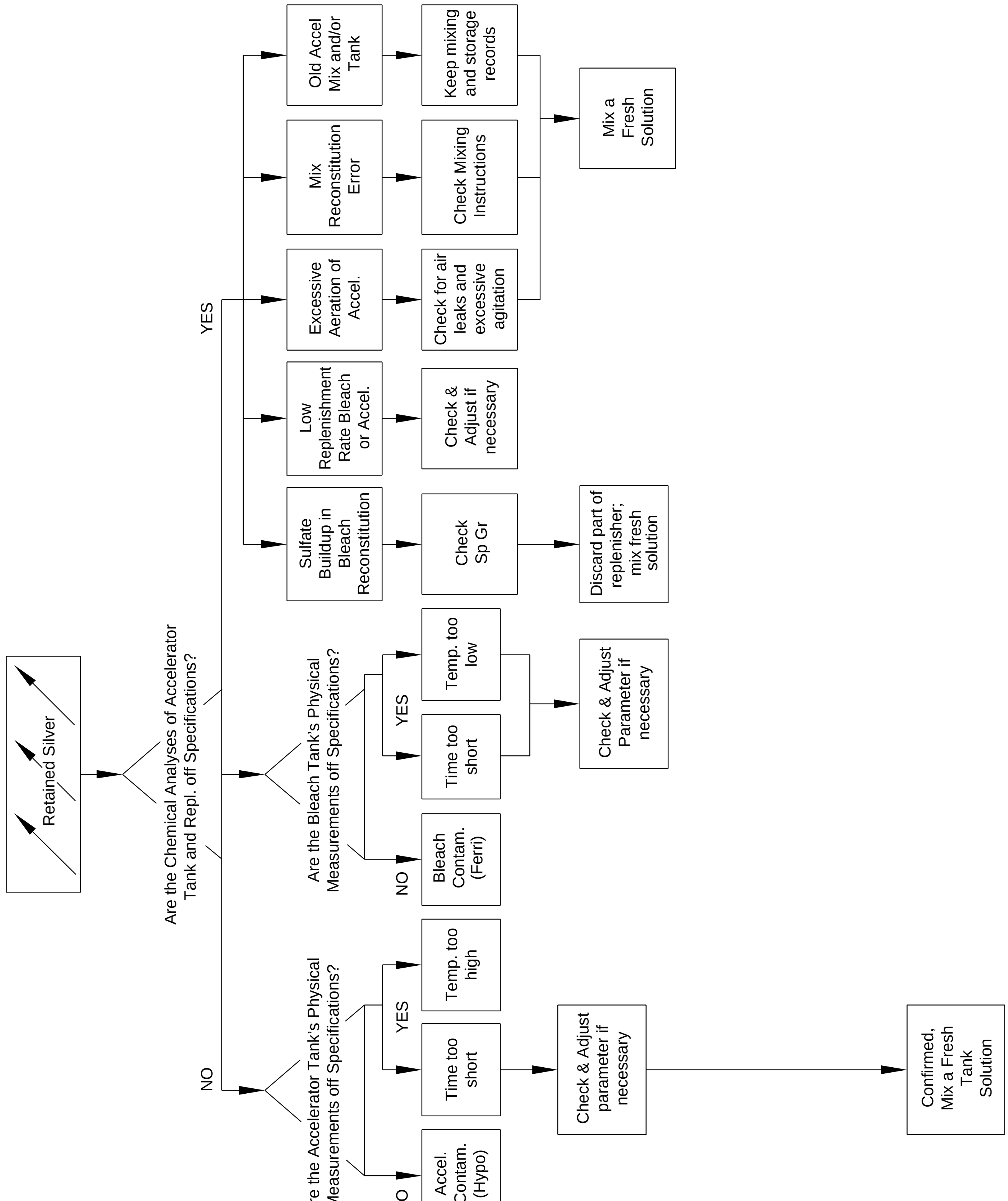
F010_0159EC

Figure 14-28 High Color Developer Activity



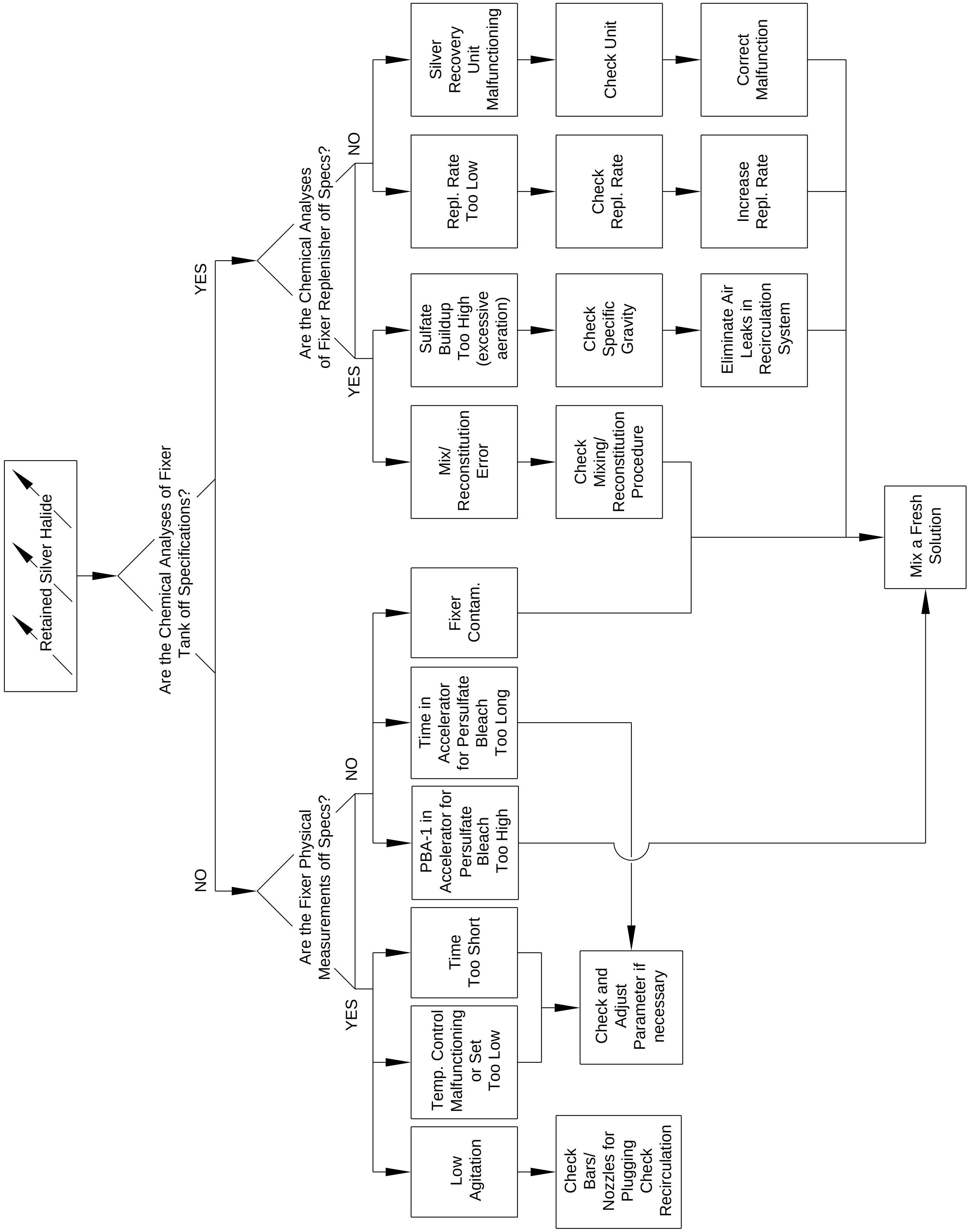
F010_0160EC

Figure 14-29 Retained Silver in Persulfate Bleach



F010_0161EC

Figure 14-30 Retained Silver Halide



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SPECIAL TESTS

There are verification tests for the suspected problems of retained silver and retained silver halide.

Retained Silver

Retained silver is the result of ineffective bleaching. The symptoms are:

1. Increased density in the lower-density areas of the film, particularly D-min. There may be an increase in high-density areas because of retained silver, but it may not be noticed.
2. The infrared density of the D-min patch increases. Normally, an infrared density (at 1,000 nm) of less than 0.07 is acceptable. A sound track densitometer is a suitable instrument for this purpose.

Verification Test:

1. Prepare a small volume of fresh ferricyanide bleach* or use a known good solution of ferricyanide bleach replenisher.
2. Immerse the processed film with suspected silver retention in the bleach for 1 - 2 minutes. Agitate by moving the film strip manually. Wash the film for 30 - 40 seconds under running water.
3. Fix the strip for 1 - 2 minutes in a small volume of a fresh fixer solution, again agitating manually. Wash the film for 30 - 40 seconds.
4. Dry the film and reread the infrared density. An infrared density within the acceptable region (which had formerly been marginal or unacceptable) confirms silver retention. Lower optical densities also confirm retained silver.

Retained Silver Halide

Retained silver halide is the result of ineffective fixing. The symptoms are:

1. There are large increases in density (i.e., greater than + 0.10 R, G, and B) in both the D-min and D-max steps of the control strip. The overall contrast is only slightly increased.
2. The infrared density of the D-max patch is normal. Normally, an infrared density (at 1,000 nm) of less than 0.07 is acceptable. A sound track densitometer is a suitable instrument for this purpose.
3. Opaque streaks are generally visible when the strip is viewed with reflected light.

Verification Test:

1. Re-fix the processed control strip for 1 - 2 minutes in a small volume of a fresh fixer replenisher solution. Agitate by moving the film manually. Wash the film for 30 - 40 seconds under running water.
2. Dry the film and reread the densities. If the D-min and D-max readings are down to normal control levels after refixing and/or the opaque streaks disappear, the problem can be attributed to retained silver halide.

* If you are unable to prepare a fresh ferricyanide bleach, prepare a fresh persulfate accelerator and bleach. Follow normal times and temperatures.

PROCESSED FILM PROBLEMS

Problem	Appearance	Possible Source of Problem	Suggestion Corrective Action
Black lines and comets	Short, black lines and comets on emulsion surface. Shiny in reflected light.	Under certain conditions, the electrolytic silver cell in the fixer recirculation systems produces small, flocculent silver flakes. These flakes get into the fixer tank, attach to the emulsion, and then go through the fixer squeegee, where each one is smeared into a line or comet.	Use a 10- to 15-micron filter in the fixer return line from the cell, or correct operation of the cell.
Dirt particles	Dark spots and marks. Easiest to see under high-intensity specular lighting.	Dirt may consist of dust, cloth filaments, hair, skin flakes, chemical crystals, scum, etc. Such dirt can come from machine operators, air-conditioning units, incorrect construction materials, lack of solution or dryer air filters, water hardness, poor housekeeping, etc.	Establish and follow good laboratory cleanliness procedures. For more information on laboratory cleanliness, refer to Module 2.
	Yellow particles on surface.	Low fixer pH causes the formation of sulfur particles in the fixer.	Maintain the fixer pH within specifications.
Dots equally spaced apart, repeating	Showers of dots on emulsion.	Soft touch tire pressing on the emulsion during processing.	Be certain the emulsion does not ride on spools with soft-touch tires.
Emulsion skivings	Small particles of emulsion sheared from the film edges and deposited on the film surface.	Spools improperly aligned, or with burrs.	Check the machine spools.
Ferrotyping	Irregular, shiny areas on the emulsion surface.	Wet or tacky emulsion at processor windup.	Adjust the dryer to provide adequate film drying.
		High windup tension on unprocessed films.	Reduce the windup tension.
		Unwinding and rewinding unprocessed cold film without allowing it to reach room temperature.	Always allow adequate time for film to come to room temperature before using.
Fungus or algae deposits	Light irregular smears, streaks, and spots.	Fungi and algae tend to form on the inside walls of the wash tanks. Their presence is indicated by a slippery and slimy feel to the tank walls.	A 5 1/4 percent solution of sodium hypochlorite, available as household liquid bleach (e.g., Clorox), can be used to clean the tank in order to control the formation of fungi and algae. See *Control of Biological Growths* in Module 2.
Newton's rings	Fuzzy, erratic, faintly colored lines.	High or uneven printer gate pressure.	Adjust printer.
		Low relative humidity in printing room.	Raise relative humidity to 60 percent.
		Preprint film was dried too fast or overdried.	Adjust drying conditions of preprint film.
Reticulation	Rough emulsion surface.	High solution temperatures.	Adjust to specifications.
		Dryer temperature too high or relative humidity too low.	Adjust to specifications.
Scalloped or fluted edges		Excessive tension on the film strand.	Check the processing machine for excessive tension in the film loops caused by a high rack or improper machine drive. Check for improper threading. Rectify either condition.

Problem	Appearance	Possible Source of Problem	Suggestion Corrective Action
Scratches	Light lines parallel to the film edges.	Old, hard, worn, crystal-laden, or maladjusted wiper-blade squeegees.	Use spring-loaded wiper blade squeegees of 40-durometer hardness or less. Keep them clean, and replace them when worn.
		Cinching a roll of film before or after processing.	Be certain that the machine take-up does not jerk the film roll. Train film handlers in proper film rewinding techniques.
		Improper loading of processing machine.	Always handle film with care. Examine equipment for sharp edges, burrs, etc. and eliminate them.
		Machine spools that are not rotating freely or are out of line.	Check spools regularly, and replace bearings when necessary.
		Chemical crystals or other foreign material on spools.	Spools and racks should be cleaned regularly according to the procedures in the machine maintenance section of this manual.
		Improper machine threading (a twist in the film) or improper splices.	These problems should be corrected according to normal processing procedures.
Shoreline	Fuzzy contour lines near the edges of the film.	Nonuniform drying of the film emulsion.	Reduce the temperature, or increase the relative humidity of the air in the drying cabinet.
Static marks	Blue streaks, spots and dots.	Rapid rewinding or transporting film in low relative humidity.	Unprocessed film should not be rewound at high speed. The relative humidity in the rewinding area should be 50 percent or greater.
		Emulsion contact with flat electrophoretic rollers before processing.	Only undercut rollers should come in contact with the emulsion surface. Use conductive materials on the rewind, load accumulator, etc., and ground them.
Tacky film		Inadequate final film squeegee action.	Check the air flow, alignment and cleanliness of the final squeegee.
		Inadequate drying conditions.	Check the temperature, relative humidity, and flow rate of the air in the dryer cabinet. The heaters or the fan may not be functioning properly, or the air filters may be plugged with dirt. If the dryer uses recirculated air, be sure it is mixed properly with incoming air. Also check the humidity control of recirculated air. If the film is still tacky after all possible normal corrective measures have been taken, as a temporary measure, increase the temperature of the dryer air. Because increased air temperature can be injurious to the film, such action requires close attention to the physical appearance of the film.
Water spots	Irregular areas on emulsion surface best seen in specular reflected light.	Lines, drops, or puddles of water allowed to enter the dryer on the film.	The final squeegee in the process must be very efficient and must remove virtually all water from the emulsion surface.

Processing EASTMAN EKTACHROME Color Reversal Films, Module 14
Effects of Mechanical & Chemical Variations in Process RVNP

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