

Using KODAK Control Strips for Processes AR-5 and AN-6

Kodak

TECHNICAL DATA / CHEMICAL

March 2010 • TI-2220

INTRODUCTION

This information is excerpted from a section on control strips in the process manual entitled "Using Processes AR-5 and AN-6 for KODAK Color Aerial Films," Kodak publication Z-200. Refer to the manual for more detailed information on process monitoring and troubleshooting.

Monitor the process systematically as suggested in Part D using the appropriate KODAK Control Strips for Process AR-5 and/or Process AN-6. This will provide reliable data for evaluating and controlling the process. The differences between the red, green, and blue density readings of the control strips and the corresponding reference strip values provide control values which are plotted on a Kodak Color Process Control-Plot Record Form (for use with Monitoring Programs), No. Y-55. These plots indicate any deviation of the process from standard, and may help to determine the degree and type of corrective action required to maintain the process within the appropriate tolerance limits.

DENSITOMETERS

When reading the reference and control strips, use a precision densitometer that is capable of measuring transmission densities from 0 to 4.0, such as the Macbeth TD-504 densitometer, or equivalent. The densitometer should be equipped with a heat-absorbing glass (Corning 4602 [5.0 mm], Pittsburgh 2043 [4.0 mm], or equivalent), as well as a dichroic interference filter; these accessories, along with the proper reading filters, may be obtained from the densitometer manufacturer.

For best results in reading the reference and control strips for Processes AR-5 and AN-6, use KODAK Calibrated Densitometer Filters to read Status A and Status M, respectively, (red, green, and blue) densitometry; these filters are selected and calibrated to conform to extremely close spectral tolerances. Furthermore, these filters are protected by a cemented glass envelope which protects the filters against fading, facilitates their cleaning, and extends their useful life.

Note: The terms "red," "green," and "blue" used throughout this manual refer to the colors of the densitometer filters through which the readings of the control strips and reference strips are made.

These filters primarily measure the cyan, magenta, and yellow dye densities.

To ensure the proper operation of the densitometer, carefully follow these procedures:

1. Follow the detailed instructions furnished with the densitometer regarding the correct setup, use, and maintenance of the instrument.
2. Check the densitometer at least once daily to be sure that it is calibrated and operating properly. For this purpose, use a "standard" such as the KODAK Transmission Densitometer Check Plaque, CAT No. 170 1986; instructions for its use are included with the plaque.
3. Each person using the densitometer should be responsible for its proper use, and should be given instructions in both the precise reading of reference and control strips as well as the proper recording of the control values on the Y-55 Record Form.
4. Densitometer readings of the reference and control strips should be made in the center of the density step. If, for some reason, the center of the density step is badly scratched or streaked, process and evaluate another control strip.

Note: Any error in calibration or operation of the densitometer, or in reading the reference or control strips, could be misinterpreted as a variation in the process; if a correction is made to the process on this basis, it would unduly complicate the control of the processing system.

The KODAK Control Strips for Process AR-5 (CAT No. 847 0367) and AN-6 (CAT No. 114 8089) are pre-exposed, unprocessed strips provided in a can as a continuous roll 35 mm wide x 100 feet long. The rolls are notched every 9 1/2 inches, and each roll contains approximately 120 control strips. A reference strip of the same emulsion code as the control strips is packaged in each box. The reference strip has been exposed in precisely the same manner as the control strips, but has been processed under carefully controlled conditions by Eastman Kodak Company. The label on each box lists the Code Number of the reference and control strips; in addition, the Code Number is printed on each strip, as shown in Figure 1. Instructions are packaged with the control strips outlining proper use of the reference strips. Information on correction factors and their application is also included in each box of strips.

Figure 1 Insert -- KODAK Control Strips for Process AR-5 and Process AN-6 not available electronically, contact TI Office or Aerial Imaging.

STORAGE AND HANDLING

Each roll of control strips is shipped under refrigerated conditions in a sealed can. Immediately upon receipt, place the control strips in a freezer at 0° F (-18° C) or lower in order to minimize latent image changes. The reference strip should be removed from each can at this time and kept at room temperature in its envelope and protected from light, excessive heat and dirt. The reference strip should be retained and read occasionally to verify that densitometry has not changed.

Control strips must be handled in total darkness. They should be handled by their edges to prevent fingerprinting and surface damage. Whenever the can of control strips is removed from the freezer, allow it to warm up to room temperature before opening. This will prevent moisture from condensing on the frozen film which may cause film sticking, static markings, or moisture mottle.

To minimize temperature effects on the exposed, unprocessed control strips, it is imperative that they be kept frozen until needed. For convenience, cut the roll of control strips into individual strips approximately one-quarter inch before the notch. (The notch is used for strip orientation.) Place the control strips in several individual light-tight containers and return them to the freezer. This will prevent the entire roll from being subjected to temperature changes or accidental fogging. Each container should contain one day's supply of control strips; discard any unused strips at the end of the day.

Use all of the control strips of one Code Number before changing over to control strips of another Code Number. When changing to a new Code Number, be sure to use the new reference strip and the appropriate correction factors for the new reference strip code.

FREQUENCY OF USE

On start-up of the processor, review the daily checklist (Appendix C in the manual) to ensure that the processor is up to temperature and ready to operate. This check will identify any improper operating conditions that must be corrected prior to processing the control strip or exposed film.

It is recommended that a control strip be processed and analyzed:

- before processing customer work at the beginning of the day.
- once every hour during continuous processing operations.
- with each batch of customer film for discontinuous processing operations.
- whenever process problems are suspected.
- whenever fresh tank solutions are used.
- after any change to the process or after any corrective action (pH adjustment, temperature change, etc.) to ensure the desired results.

Note: Wait several minutes after processing customer film before monitoring the process to preclude turbulence patterns on the control strip.

PROCESS CONTROL STRIPS

It is important to orient the step tablet exposure on the control strip properly during processing. The low-density (LD) end should enter the processor first with the emulsion down. The roll of control strips is packaged with the emulsion wound in and the low-density (LD) exposure coming off the roll first. For individual strips, the low density (LD) end is that end with the cutoff Notch. The assumes that each strip was prepared by cutting above the notch approximately one-quarter inch, as suggested in part C. The strips must not be cut below the notch (i.e., towards the roll) or the strip orientation will be reversed.

Splice the LD end of the control strip to a KODAK VERSAMAT Leader Tab (CAT No. 111 1814, 11 x 24 inches) using KODAK VERSAMAT Splicing Tape (CAT No. 857 7546, 1 in. x 36 yd), or an equivalent that is not active photographically and which will adhere to the materials in processing solutions. Feed the leader tab into the processor so that the emulsion of the control strip faces down.

IDENTIFICATION

After the control strip has been processed, identify it with the date and hour of processing; use a pressure-sensitive label, making sure that the label is not in the reading area of the density patches.

Identify each control strip with a "Control Number" by using a sequential numbering system. If more than one processor is in operation, the control number should have a letter prefix that identifies the processor through which the strip was processed. For example, the control number for the first control strip through Machine A will be A-1, the second control number A-2, etc. For Machine B, the control number of the first control strip will be B-1, the second control number B-2, and so on.

AIM VALUES

Each box of control strips contains a reference strip packaged in a clear, protective sleeve in a separate envelope. Instructions on reading the strips, applying correction factors, and specific correction factors for that control strip code number are also enclosed. Upon receipt, remove all the reference strips from all the boxes having the same batch or Code Number and immediately place the containers of control strips in a freezer at 0° F (-18° C).

To determine the reference values for a particular process, proceed as follows:

1. Check the transmission densitometer carefully as per the instruction manual supplied by the manufacturer. In addition, use the KODAK Transmission Densitometer Check Plaque (CAT No. 170 1986), or equivalent, for verification of densitometer performance. Detailed procedures are contained in the instruction sheet that accompanies each Check Plaque.
2. Place the reference strip on the densitometer stage with the emulsion side up. While these strips have been designed to provide minimum variation within the exposed area, the center of the steps should be read to minimize any effects from development variations that may have occurred at the edge of the control strip. All reference strips having the same code number should be read at the same time and the reading averaged.

3. Make all densitometer readings using Status A (process AR-5) or Status M (process AN-6) red, green, and blue filters at three places on each Reference Strip as follows:

Process AR-5		Process AN-6	
D-max	Opposite the clear dot at the dense end of the strip	D-min	Opposite the black dot at the clear end of the strip
Step 4 (LD)	Low density step indicated by an exposed detent within the exposed area	Step 8 (LD)	Indicated by an exposed detent within the exposed area
Step 6 (HD)	High density step indicated by an exposed detent within the exposed area	Step 5 (HD)	High density step indicated by an exposed detent within the exposed area

The location of these areas on the reference strips is shown

schematically in Figure 1.

4. Read all reference strips with the same Code Number as indicated in Step 3. Average the readings by adding the red, green or blue readings for each step and dividing by the number of strips that were read. After the reference strips have been read, return them to their original envelopes and store them in a cool, dry, and dark area.
5. Record the (averaged) reference strip readings as shown in the examples contained in Tables 1 and 2. Apply correction factors to obtain the corrected reference (aim) values as shown in these examples.

Table 1: Determination of Reference (Aim) Values for Process AR-5, 117° F (47.2° C)

Step	Reference Code AR-5-4088	Status A Filter		
		Red	Green	Blue
D-max	Reference Strip Reading	3.70	3.60	3.12
	Correction Factor	+0.10	+0.01	+0.21
	Aim Value	3.80	3.61	3.33
Step 6	Reference Strip Reading	2.09	1.75	1.36
	Correction Factor	+0.25	+0.17	+0.29
	Aim Value	2.34	1.92	1.65
Step 4	Reference Strip Reading	0.76	0.55	0.46
	Correction Factor	+0.17	+0.16	+0.13
	Aim Value	0.93	0.71	0.59

Note: A different set of correction factors are required to determine the (aim) values for the 119° F (48.3° C) cycle. Both sets of correction factors are supplied with each AR-5 Reference Strip.

Table 2: Determination of Reference (Aim) Values for Process AN-6

Step	Reference Code AN-6-4028	Status M Filter		
		Red	Green	Blue
D-min	Reference Strip Reading	0.12	0.19	0.16
	Correction Factor	0.00	0.00	0.00
	Aim Value	0.12	0.19	0.16
Step 8	Reference Strip Reading	0.57	0.57	0.38
	Correction Factor	+0.05	0.00	-0.01
	Aim Value	0.62	0.57	0.37
HD	Reference Strip Reading	1.34	1.35	1.09
	Correction Factor	+0.03	+0.01	-0.03
	Aim Value	1.37	1.36	1.06

Note: The reference strip readings in Tables 1 and 2 are the averages of all strips with the same Code Number; the correction factors are supplied with the Control Strips. They are different for each code number; they are identical for all boxes with the same code number.

- Using a Kodak Color Process Control-Plot Record Form, No. Y-55, record the Reference Strip Code Number in the appropriate space in the upper-left margin, as shown in Figure 2. Using colored pens or pencils, record the red, green, and blue (aim) values from Tables 1 and 2 in the left margin, as shown in Figure 2.

For Process AR-5, use the top area of the Y-55 Form to record D-max, the next lower area for Step 6 (HD) and third area for Step 4 (LD). For Process AN-6, use the top area for Step 5 (HD), the second area for Step 8 (LD) and the third area for D-min.

Figure 2 Insert -- Recording of Corrected Reference (AIM) Values on KODAK Record Film No. Y-55 not available electronically, contact TI Office or Aerial Systems.

RECORDING THE CONTROL STRIP READINGS

When reading control strips, always use the same transmission densitometer that was used to read the reference strip. Also, make sure to always compare control strips and reference strips of the same Code Number. For determining control values, proceed as follows:

- Check the transmission densitometer carefully per the instruction manual supplied by the manufacturer. See Part G and Kodak Publication Z-99, Introduction to Color Process Monitoring, CAT No. 130 4997, for additional suggestions.
- Place the control strip on the densitometer stage with the emulsion side up and read the densities of the appropriate steps for your process type through red, green, and blue Status A (AR-5) or M (AN-6) Filters. The readings should be made in the center of the exposed areas. Repeat these measurements to ensure their accuracy. For Process AR-5, read the D-max (opposite the clear dot at the dense end of the strip), Step 6 (High Density) and Step 4 (Low Density); for Process AN-6, read the D-min (opposite the black dot at the low density end of the strip), Step 8 (Low Density) and Step 5 (High Density). Refer to Figure 1 for a schematic description of these areas.
- Record the control strip readings as shown in the examples contained in Table 3 below. Save the strip for future reference; be sure each strip is properly labeled before placing it in a cool, dark, and dry storage area.

Table 3: Recording of Control Strip Readings

Process AR-5, 117° F (47.2° C) Strip Ref No. AR-5-4088-15				Process AN-6 Strip Ref No. AN-6-4028-27			
Step	Red	Green	Blue	Step	Red	Green	Blue
D-max	3.90	3.74	3.31	D-min	0.13	0.17	0.15
6 (HD)	2.30	1.96	1.64	8 (LD)	0.64	0.58	0.40
4 (LD)	0.95	0.74	0.65	4 (HD)	1.36	1.38	1.10

- In order to calculate the control values, subtract the aim values (Tables 1 and 2) from the control strip readings (Table 3). If the control strip reading is greater than the aim value, the difference (i.e., control value) will have a plus (+) sign; if it is smaller, the control value will have a minus (-) sign; if the control strip reading and the aim value are identical, the control value will be zero.

Plot the control values on KODAK Record Form No. Y-55, as shown in Figure 2. In this example, the control values obtained from the data in Tables 2 and 3 appear as the second data point from the left in both control plots (i.e., Control No. 15 for Process AR-5 and Control No. 27 for the Process AN-6).

PLOTTING CONTROL VALUES

1. Use a separate Y-55 Record Form for each processing machine and for each process type: 117F (47.2C) Process AR-5, 119F (48.3C) Process AR-5, or Process AN-6.
2. At the top of the record form, under "Control Number," record the letter and number assigned to the processed control strip (e.g., A-1). At the bottom of the page, record the date and time of processing, as well as the "Process" and "Machine" designation.
3. With a red pencil, draw in dotted or solid lines for the tolerance limits shown in Table 4 for each of the designated plotted areas; for Process AR-5, also mark in the Color Balance ("CB") limits for Step 6 and Step 4.

Table 4: Tolerance Limits

	Process AR-5 117° F or 119° F (47.2° C or 48.3° C)			Process AN-6		
	Step 4 (LD)	Step 6 (HD)	D-max	D-min	Step 8 (LD)	Step 5 (HD)
Action Limits	--	--	-0.20	+/- 0.03	+/- 0.08	+/- 0.12
Control Limits	+/- 0.10	--	-0.25	+/- 0.05	+/- 0.10	+/- 0.15
CB Spread ¹	0.08	0.13	--	--	--	--

¹CB, or Color Balance Spread, is the maximum allowable density difference between any two colors at HD or LD. Values exceeding these limits may result in an unsatisfactory color balance. No CB limits are specified for Process AN-6. CB limits are described in part J.

4. Use a red pencil for red control values, a green pencil for green control values, and a blue pencil for blue control values.
5. Plus values are plotted above the reference (0) line, minus values are plotted below the reference (0) line, and zero values are plotted on the reference (0) line. Each horizontal line on the Y-55 record form represents one density unit (0.01).
6. After plotting the control values, connect the points you have just plotted with the previously plotted points, to give a continuous graph, as shown in Figure 2. For clarity and ease of interpretation, the first control values plotted after a daily or weekend shutdown may be left unconnected from the previously plotted points.
7. Whenever changes are made to the process or the process plots out of control, the process control operator should record the cause and any corrective action taken, and initial the record form. Such notations will help in making future decisions.
8. EXAMPLE: In Figure 2, Process AR-5, Control Number 15, the red D-max of the control strip was 3.90 and the reference value was 3.80 yielding a control value of +0.10. Therefore, a red dot was placed on the tenth line above the reference (or zero) line. Similarly, the green value of the control strip was 3.74, 0.13 units

greater than the green D-max reference value, and a green dot was placed thirteen units above the reference line. The blue D-max of the control strip was 3.31, 0.02 units lower than the blue reference value, and a blue dot was placed on the second horizontal line below the reference line. All values from Table 3 were compared with the appropriate reference values of Table 2 and plotted in Figure 2 in the same manner as described above.

DESCRIPTION OF TOLERANCE VALUES

In theory, all control strips should have control values identical to the reference values and should, therefore, plot on the reference (0) line. In practice, however, small but unavoidable variations in the processes and variations in the reference or control strips (storage, densitometry, etc.) can contribute to variations in the control values. The tolerance limits in Table 3 include allowances for these variables.

As shown in Table 4, there are three types of tolerance limits applicable to Processes AR-5 and AN-6: control limits, action limits, and color balance limits.

Control Limits

Control limits define the range of control values associated with a process in control, i.e., a process that provides the desired density(ies) for a specific exposure. When these limits are exceeded by any single point on the control plot, processing should be discontinued until the source of the out-of-control condition has been identified and remedied.

Action Limits

These provide early warning for a process drifting out of control. Although processing may continue when these limits are reached or exceeded, they signal that the process is nearing an out-of-control condition. If one or more points exceed the action limit, the cause of the process condition should be sought and corrected as soon as possible. When this condition exists, a control strip should be processed with each roll of film in order to closely monitor the process.

Color Balance Limits

Color balance limits or CB limits, are applied to Process AR-5 only and indicate the accuracy with which neutral colors (grays) are produced. If the difference between any two colors at either Step 4 or Step 6 exceeds the CB limit, the process may not produce acceptable neutral tones. If this occurs, processing should be discontinued until the source of the variation has been identified and remedied.

If out-of-limit conditions exist, do not process film; take process constantly drifts and approaches the control limits, do not wait until the limits are exceeded; take action to bring the process control values nearer to the reference line of the control plot.

Using KODAK Control Strips for Processes AR-5 and AN-6

INTERPRETATION OF THE CONTROL VALUES

The plotted graph of the control values indicates the day-to-day variations in the process and will show its relationship to the standard process level as represented by the reference (aim) values. The plotted control values also provide a continuous record which indicates the direction and magnitude of shifts in speed and color balance caused by changes in the process. Furthermore, the control values indicate whether corrective action should be taken, and serve as a guide in determining the type of corrective action that is needed.

In general, Process AR-5 is most sensitive to variations in the EA-5 First Developer, and EA-5 Color Developer. *If the primary effect is on Step 4 (Low Density), you should concentrate first on the EA-5 first developer; if the primary effect is on Step 6 (High Density) and/or D-max, first investigate the EA-5 color developer and then the EA-5 first developer. Similarly, fluctuations in Process AN-6 are caused by deviations in the AN-6 developer.*

The Process Manual (Publication Z-200) contains a section on Process Monitoring and Troubleshooting, which provides more detailed information on interpretation and corrective action for Processes AR-5 and AN-6.

USING A NEW BATCH OF CONTROL STRIPS

Considerable care has been exercised in the manufacture of KODAK Control Strips for Process AR-5 and Process AN-6. Therefore, although crossover procedures do exist which can be applied to both processes, they are generally unnecessary. However, a few precautionary steps are advisable when switching to a new batch of control strips.

1. Do not wait until the current control strips have been completely used up before evaluating a new batch.
2. Process a current control strip and a new control strip at the same time.

3. Compare each control strip with its appropriate reference value (reference strip reading to which the appropriate corrective factors have been applied). If the current strip indicates the process is in control, so should the new strip.
4. The easiest method to cross over is to process a few strips from the new batch as soon after receipt as possible and in a process that is within the appropriate control limits.
5. If the new strips do not agree with the old strips, contact an Eastman Kodak Company Specialist for Aerial Products.

Note: Keep Control Strips Frozen at 0° F (-18° C). Average all Reference Strips with the same code number.

Information is available by writing or calling:

Aerial Imaging

Eastman Kodak Company

Rochester, New York 14653-7128

(585) 253-1855

Toll-free in U.S. (877) 909-4280

Note: The Kodak materials described in this publication used with KODAK Control Strips, Process AR-5 and KODAK Control Strips, Process AN-6 are available from those dealers normally supplying Kodak products. Other materials may be used, but equivalent results may not be obtained.

Note: The contents of this publication are subject to change without notice.

Note: If you have questions or need assistance, contact your local Kodak representative.

NOTICE: While the sensitometric data in this publication are typical of production coatings, they do not represent standards which must be met by Kodak. Varying storage, exposure, and processing conditions will affect results. The company reserves the right to change and improve product characteristics at any time.

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Revised 3-10

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