



## Processing KODAK Aerial Films in Rewind Equipment and on Spiral Reels

### Black-and-White Rewind Processing

Most Kodak black-and-white aerial films have been designed both physically and sensitometrically to be processed in roller-transport processors. However, satisfactory results for some applications may be achieved by the use of rewind-processing equipment such as the Gordon/Morse M-10 Developing Outfit (Military Designator: B-5).

#### KODAK Films

Starting-point development recommendations are provided for the following films:

KODAK DOUBLE-X AEROGRAPHIC Film 2405

KODAK PANATOMIC-X AEROGRAPHIC II Film 2412

KODAK PLUS-X AEROGRAPHIC Film 2402

KODAK TRI-X AEROGRAPHIC Film 2403

KODAK Infrared AEROGRAPHIC Film 2424

#### KODAK Chemicals for Rewind Processing

Choice of developer may depend upon desired gamma; refer to the sensitometric data listed in the tables under "Development."

KODAK Developer DK-50, or others such as KODAK HC-110 Developer (Dilution A) and KODAK Developer D-19

KODAK Indicator Stop Bath \*

KODAK Rapid Fixer or KODAK Fixer

KODAK Hypo Clearing Agent \*\*

KODAK PHOTO-FLO Solution

\* A suitable stop bath can be made using 125 mL/L of KODAK 28% Acetic Acid.

\*\* Can be used to reduce washing time and conserve water.

#### Agitation:

The film must be agitated by continuously winding it from one reel to the other while it is in each of the solutions and each time it is washed or rinsed.

#### Draining the Reel:

Before advancing the reel assembly from one solution to another, perform the following operation:

Lift the reel assembly out of the solution, turn the reel until the film is taut, and then tip the entire assembly over far enough (more than 90 degrees) to permit any solution held in the pockets within the film convolutions or reel mechanism to run out. Hold the film and reel in this position for approximately 10 seconds in order to drain out most of the solution.

#### Timing or Counting:

The timing or counting of each step begins after the film is placed in the solution and wound from one reel to the other so that the film will be uniformly wet with solution before timing begins.

## Black-and-White Rewind Processing Steps

Choice of developer may depend upon desired gamma; refer to the sensitometric data listed in the tables under "Development."

For best results, keep the temperature of all solutions as close to the developer temperature as possible.

**Note:** A "pass" means winding the film from one reel completely onto the other reel. A "cycle" means winding the film from one reel completely onto the other reel and then rewinding the film back onto the first reel. If at the end of the recommended time a pass is incomplete, finish the pass in progress before proceeding to the next solution.

### Prewet—Important:

Both surfaces of the film must be thoroughly wet before actual processing begins. This is accomplished by winding the film through a tempered water bath. The prewet prevents wrap-to-wrap sticking and helps to eliminate developer streaks on films processed in rewind equipment. A suggested procedure is as follows:

1. In total darkness, wind the film (emulsion side out) from the camera spool onto one of the processor reels. Attach the tail of the film securely to the other processor reel, as required for rewinding.
2. With the reels horizontal and the empty reel at the bottom, lower the processor assembly into a wash tank full of water at 68°F (20°C), until the empty reel is totally submerged. Do not allow the upper reel and the film to become wet. It may be necessary to devise some means for holding the processor assembly in this position.
3. With constant speed, slowly wind the film completely onto the submerged reel. Lift the processor out of the tank and place it in its normal operating position, with both reels vertical and totally submerged in water.
4. Rewind the film, again at constant speed, onto the other reel. This will provide uniform and thorough wetting of the film.
5. Place the motor in position, lift the processor out of the tank, and let the water drain from the processor reels and film.

### Development:

Make one complete pass of the film in the developer; then start the timer and develop for the time indicated.

If a pass is incomplete at the end of the recommended time, finish the pass.

### KODAK DOUBLE-X AEROGRAPHIC Film 2405

KODAK Developer	Temp F (C)	Film Length (Feet)	Dev Time (Min)	Cycles	Approx Gamma	ISO A	D-min
DK-50	68 (20)	75	15	8	1.2	250	--
	68 (20)	125	10	4	1.0	250	0.12
	68 (20)	250	20	4	1.0	250	0.16
	75 (24)	125	10	4	1.0	320	0.11
D-19	68 (20)	125	10	4	1.4	500	0.13
HC-110 (A)	68 (20)	125	10	4	1.0	250	0.12
	75 (24)	125	10	4	1.3	250	0.17
	75 (24)	250	30	12	1.2	500	0.30

**KODAK PLUS-X AEROGRAPHIC Film 2402**

<b>KODAK Developer</b>	<b>Temp F (C)</b>	<b>Film Length (Feet)</b>	<b>Dev Time (Min)</b>	<b>Cycles</b>	<b>Approx Gamma</b>	<b>ISO A</b>	<b>D-min</b>
DK-50	68 (20)	125	10	4	1.3	160	0.06
	68 (20)	250	20	4	1.2	200	0.06
D-19	68 (20)	125	20	8	1.1	160	0.06
	68 (20)	250	30	6	1.0	160	0.06
HC-110 (A)	68 (20)	125	10	4	1.0	250	0.06
	75 (24)	125	10	4	1.3	250	0.09

**KODAK TRI-X AEROGRAPHIC Film 2403**

<b>KODAK Developer</b>	<b>Temp F (C)</b>	<b>Film Length (Feet)</b>	<b>Dev Time (Min)</b>	<b>Cycles</b>	<b>Approx Gamma</b>	<b>ISO A</b>
D-19	68 (20)	125	15	6	1.8	640
	68 (20)	250	15	3	1.8	640
DK-50	68 (20)	125	10	4	1.0	200
	68 (20)	250	10	2	1.0	200
	68 (20)	125	15	6	1.1	500
	68 (20)	250	15	3	1.1	500

**KODAK PANATOMIC-X AEROGRAPHIC II Film 2412**

<b>KODAK Developer</b>	<b>Temp F (C)</b>	<b>Film Length (Feet)</b>	<b>Dev Time (Min)</b>	<b>Cycles</b>	<b>Approx Gamma</b>	<b>ISO A</b>	<b>D-min</b>
D-19	68 (20)	125	10	4	1.6	50	0.12
	68 (20)	250	20	4	1.6	50	0.27
DK-50	68 (20)	125	20	8	2.0	50	0.14
HC-110 (A)	68 (20)	125	10	4	1.6	50	0.15
	75 (24)	125	10	4	1.8	50	0.38

**KODAK Infrared AEROGRAPHIC Film 2424**

<b>KODAK Developer</b>	<b>Temp F (C)</b>	<b>Film Length (Feet)</b>	<b>Dev Time (Min)</b>	<b>Cycles</b>	<b>Approx Gamma</b>	<b>ISO A</b>
D-19	68 (20)	50	10	15	2.3	320
	68 (20)	75	15	15	2.3	320
	68 (20)	125	20	12	2.3	320
	68 (20)	250	30	9	2.3	320
DK-50	68 (20)	50	10	15	1.5	250
	68 (20)	75	15	15	1.5	250
	68 (20)	125	20	12	1.5	250
	68 (20)	250	30	9	1.5	250
	68 (20)	50	15	22	2.0	160
	68 (20)	75	25	25	2.0	160

**Note:** Aerial film speeds for infrared-sensitive films are not obtainable using radiometric log H values. The ISO A values given have been determined from empirical data in order to provide relative exposure values to correspond to panchromatic films with no appreciable infrared sensitivity.

**Rinse:**

Use KODAK Indicator Stop Bath at 65 to 75°F (18 to 24°C). Make one complete pass of the film in the rinse solution; then rinse for 5 minutes (2 cycles for 125-foot lengths or 1 cycle for 250-foot lengths).

**Fix:**

Use KODAK Rapid Fixer or KODAK Fixer at 65 to 75°F (18 to 24°C). When using Rapid Fixer, make one complete pass of the film in the fixing bath; then fix for 4 cycles (20 minutes for 250-foot lengths or 10 minutes for 125-foot lengths). When using KODAK Fixer, double the fix times recommended for Rapid Fixer.

**Wash:**

Make one pass of the film in running water at 65 to 75°F (18 to 24°C) and continue washing for 30 minutes. Maintain a water-flow rate of 10 changes per hour at the process temperature.

**Alternative Rapid Wash:**

To reduce washing time and to conserve water, use KODAK Hypo Clearing Agent (prepared as directed on the carton).

First rinse the film in running water for one pass plus one cycle. Then treat the film in Hypo Clearing Agent solution for one pass plus one cycle. For lengths shorter than 75 feet, the minimum treatment time is 30 seconds. Finally, wash the film in running water for 5 to 10 minutes (one pass plus two complete cycles). Maintain a water-flow rate of 10 changes per hour at the process temperature.

**Dry:**

After washing, treat the film in KODAK PHOTO-FLO Solution (prepared as directed on the bottle label) to minimize drying marks. Dry the film in a dust-free area. It is important that both sides of the processed film be dry to prevent sticking when the film is wound in rolls. The film should be dried to an equilibrium with 45 to 55 percent relative humidity. This will keep size changes to a minimum.

## Color Rewind Processing

Kodak color aerial films are designed to yield optimum results with modern, high temperature, continuous-processing machines. Although not a primary recommendation, the following films may be processed in equipment such as the Gordon/Morse M-10 developing outfit (Military Designator: B-5):

KODAK AEROCOLOR III Negative Film 2444

KODAK AEROCOLOR HS Film SO-846

KODAK AEROCHROME II MS Film 2448

KODAK AEROCHROME III Infrared Film 1443\*

KODAK AEROCHROME III Infrared NP Film SO-734\*

\* For best results, if either 1443 or SO-734 Film is to be rewind-processed, expose the film with a KODAK Color Compensating Filter CC10M plus the usual KODAK WRATTEN Gelatin Filter No. 12 / deep yellow to offset the different color balance produced by this process.

### Processing Chemicals for Color Rewind Processing

Use KODAK FLEICOLOR Chemicals for Process C-41 to process KODAK AEROCOLOR III Negative Film 2444 and KODAK AEROCOLOR HS Film SO-846.

Eastman Kodak Company no longer offers packaged chemicals for rewind processing of KODAK AEROCHROME Films. Customers wishing to use rewind equipment or spiral reels must mix processing solutions from bulk chemicals. Formulas for these chemicals may be obtained by contacting Aerial Imaging.

**Caution:** The bleach corrodes most metals and, therefore, should not be left in metal equipment any longer than is absolutely necessary. Bleach, however, can be stored in receptacles made of red brass, polyethylene, porcelain, rubber, or glass; it may also be stored in enamelware receptacles that are free from surface cracks or chips.

### General Recommendations for Color Rewind Processing

The following general recommendations are for rewind processing 9 1/2-inch x 125-foot rolls of color aerial films.

- Fresh solutions should be used for each roll of film and should be discarded after use.
- For best results, keep the temperatures of all solutions as close as possible to the developer temperature.
- The film must be agitated by continuously winding it from one reel to the other while it is in each of the solutions and each time it is rinsed or washed.
- Before the reel assembly is advanced from one solution to the other, the following operations must be performed:  
Lift the reel assembly out of solution, turn the reel until the film is taut, and then tip the entire assembly over far enough (more than 90 degrees) to permit any solution held in the pockets within the film convolutions or mechanisms to run out. Hold the film and reel in this position for approximately 10 seconds in order to drain out most of the solution. The drain time should be included in the time specified for each processing step.
- The timing or counting of each step begins after the film is placed in the solution and is wound from one reel to the other so that the film is uniformly wet with the solution before timing begins.

## Color Rewind Processing Steps

Using the times provided in the following table, develop the film at  $85 \pm 1^\circ\text{F}$  ( $29.4 \pm 0.6^\circ\text{C}$ ) as follows:

1. In total darkness, wind the film (emulsion side out) from the camera spool onto one of the processor reels. Attach the tail of the film securely to the processor reel, as required for rewinding.
2. Prewet the film in a tempered water bath, according to the suggested procedure in the black-and-white processing section.

3. Lift the processor reel assembly out of the prewet tank and place it in its normal operating position, with both reels vertical and totally submerged in the developer. Wind the film from one reel to the other to uniformly wet the film with developer.
4. Place the motor in position, start it, and begin timing the developer step. Near the end of the development period, let the motor roll the film onto one of the reels. Remove the assembly from the developer tank, and drain the film and reel assembly. Include the drain time in the total development time.

**Note:** The developer time/temperature in the following tables are a guideline to be used as a starting point only; adjustments may be necessary.

Proceed in a similar manner for the remainder of the processing solutions, using the times and temperatures provided in the following tables.

A motor-speed control is recommended so that the film will be wound onto one reel near the end of the development time.

**Processing Sequences**

**2444 and SO-846 Films: 9 1/2-in. x 125-ft. and 9 1/2-in. x 50-ft. rolls**

<b>Processing Step</b>	<b>Time<sup>[1]</sup> (Minutes)</b>	<b>Temperature</b>
FLEXICOLOR Developer 9 1/2 in. x 125 ft 9 1/2 in. x 50 ft <sup>[3]</sup>	15 9	90 ± 0.5°F (32.2 ± 0.3°C) 90 ± 0.5°F (32.2 ± 0.3°C)
Wash <sup>[4]</sup>	4	85 ± 2°F (29.4 ± 1.1°C)
FLEXICOLOR Bleach III	10	85 ± 2°F (29.4 ± 1.1°C)
FLEXICOLOR Fixer and Replenisher	10	85 ± 2°F (29.4 ± 1.1°C)
Wash	8	85 ± 2°F (29.4 ± 1.1°C)
FLEXICOLOR Stabilizer III and Replenisher <sup>[2]</sup>	1	85°F (29.4°C)
Dry	—	—

<sup>[1]</sup>Includes drain time.

<sup>[2]</sup>Minimum of one pass.

<sup>[3]</sup>The processing of the short roll (50 feet) produces the same color balance and overall speed, but also produces a negative of slightly higher contrast.

<sup>[4]</sup>Room lights may be turned on after completion of this step.

**2448, 1443 and SO-734 Films: 9 1/2-in. x 125-ft.  
 rolls**

Processing Step	Time <sup>[1]</sup> (Minutes)	Temperature
First Developer 2448 Film 1443 and SO-734 Film	6 1/2 9	85 ± 0.5°F (29.4 ± 0.3°C) 85 ± 0.5°F (29.4 ± 0.3°C)
First Stop <sup>[3]</sup>	2	85 ± 2°F (29.4 ± 1.1°C)
Wash	4	85 ± 2°F (29.4 ± 1.1°C)
Color Developer	15	85 ± 1°F (29.4 ± 0.6°C)
Second Stop	3	85 ± 1°F (29.4 ± 0.6°C)
Wash	3	85 ± 2°F (29.4 ± 1.1°C)
Bleach	10	85 ± 2°F (29.4 ± 1.1°C)
Fixer	10	85 ± 2°F (29.4 ± 1.1°C)
Wash	8	85 ± 2°F (29.4 ± 1.1°C)
Stabilizer <sup>[2]</sup>	1	85°F (29.4°C)
Dry	—	—

<sup>[1]</sup>Includes drain time.

<sup>[2]</sup>Minimum of one pass.

<sup>[3]</sup>Room lights may be turned on after completion of this step.

## Processing on Spiral Reels

Kodak aerial films may be processed on stainless steel spiral reels; however, sensitometric and image-structure characteristics will vary from the published data.

For processing black-and-white aerial films on spiral reels, the chemicals, times, and temperatures recommended for rewind processing may be used as a starting point for testing.

The following instructions apply to the 70 mm size AEROCHROME III Films in lengths up to 15 feet (4.6 metres) using the KODAK Processing Rack with 3 1/2-gallon tanks. For AEROCOLOR III Negative Film 2444, use a starting developer time of 8 minutes.

### Processing Sequence—70 mm x 15 feet (4.6 metres)

Refer to the processing notes following this table for additional information.

**KODAK AEROCHROME Films**

Processing Step	Time (Minutes)	Temperature
First Developer 2448 Film 1443 and SO-734 Film	5 7	85 ± 0.5°F (29.4 ± 0.3°C) 85 ± 0.5°F (29.4 ± 0.3°C)
First Stop	2	85 ± 2°F (29.4 ± 1.1°C)
Wash	4	85 ± 5°F (29.4 ± 3.0°C)
Color Developer	15	85 ± 2°F (29.4 ± 1.1°C)
Second Stop	3	85 ± 2°F (29.4 ± 1.1°C)
Wash	3	85 ± 5°F (29.4 ± 3.0°C)
Bleach	5	85 ± 2°F (29.4 ± 1.1°C)
Fixer	6	85 ± 2°F (29.4 ± 1.1°C)
Wash	6	85 ± 5°F (29.4 ± 3.0°C)
Stabilizer	1	85 ± 2°F (29.4 ± 1.1°C)
Dry—Remove film from reels; dry film at temperature not exceeding 110°F (43°C).		

**Spiral Reel Processing Notes:**

Check the temperature of all solutions, turn off all lights, and load the film into the reels. Load the rack. The times indicated include drain time.

1. Start by placing the loaded rack into the first developer, and start the timing operation. At the end of the development time, including the drain time, proceed to step 2. Strict adherence to the recommended time, temperature, and agitation procedure is very important.
4. Stop the development by treating the film in the first stop bath for 2 minutes. Room lights may be turned on after completion of this step.
 

Do not interchange first and second stop baths after they have been used in processing.
5. Wash the film in running water for 4 minutes.
 

Do not use a reversal exposure. Reversal is accomplished chemically in the color developer.
6. Develop the film in the color developer for 15 minutes. (In a replenished system, develop for 9 minutes.)
7. Stop the development by treating the film in the second stop bath for 3 minutes.
8. Bleach the film in the bleach solution for 5 minutes.
9. Wash the film in running water for 3 minutes.
 

The appearance of the film does not indicate the degree of bleaching.
10. Fix the film for 6 minutes.
11. Wash the film in running water for 6 minutes.

12. Stabilize the film by treating it in the stabilizer solution for 1 minute.

Do not rinse in water after this solution.

13. Dry the film by removing it from the reels and hanging the strips up to dry in a dust-free atmosphere. It is important that both sides of the processed film be dried thoroughly. If a drying cabinet is used, the air should be filtered and its temperature must not exceed 110°F (43°C).

**Agitation Procedures for Spiral Reels**

**First Developer and Color Developer**

Lower the loaded rack into the solution and tap it vigorously against the bottom of the tank to dislodge any air bubbles clinging to the film. Then lift the rack completely out of the developer and reimmerse it several times during the first 10 seconds. Allow the rack to remain undisturbed for 20 seconds.

For the remaining time in each developer, proceed as follows:

Lift the rack out of the solution, but just clearing the solution by about 1/2 inch. Avoid dwell time out of the solution. Reimmerse the rack quickly, completing about seven cycles in 7 seconds. Repeat this procedure every 30 seconds.

Just before the end of the development time, drain the rack for 10 seconds.

**First and Second Stop Baths, Bleach, Fixer, and Washes**

Agitate continuously for the first 15 seconds by lifting the rack completely out of the solution and reimmersing it about 8 times. Thereafter, agitate once each minute by lifting the rack completely out of the solution and draining it for 5 seconds from one corner. Alternate the direction of tilting the rack for draining.

For further information, write or call:

Aerial Imaging

Eastman Kodak Company

Rochester, New York 14653-7128

(585) 253-1855

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

**Note:** The Kodak materials described in this publication 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.

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