8 RACK-AND-TANK PROCESSORS

STEPS AND CONDITIONS

Table 8-1
Steps and Conditions—Rack-and-Tank ProcessorsOne

Step	Time* (Minutes:Seconds)			Temperature °C (°F)	Comments†
	Lower Limit	Aim	Upper Limit		
Perform these steps in total darkness.					
First Developer‡	5:00*	6:00*	7:00*	36.7 to 39.4* (98 to 103)*	NitrogenJ R, F
First Wash	1:00	2:00	4:00	33.3 to 39.4 (92 to 103)	AirJ
Reversal Bath	1:00	2:00	4:00	24 to 39.4 (75 to 103)	None
Remaining steps can be done in room light.					
Color Developer‡	5:00	6:00	7:00	36.7 to 39.4 (98 to 103)	NitrogenJ R, F
Pre-Bleach	2:00	2:00	4:00	24 to 39.4 (75 to 103)	None
Bleach	6:00	6:00	8:00	33.3 to 39.4 (92 to 103)	AirJ R, F
Fixer	4:00	4:00	6:00	33.3 to 39.4 (92 to 103)	AirJ R, F
Wash	2:00	2:00	4:00	33.3 to 39.4 (92 to 103)	AirJ
Wash	2:00	2:00	4:00	33.3 to 39.4 (92 to 103)	AirJ
Final Rinse	0:30	1:00	4:00	Ambient	None
Dry	As needed			Up to 63 (145)	

* Transfer time and agitation will affect solution times. Adjust the first-developer time and/or temperature to match the aim value for the LD step densities. Once you select a first-developer time and temperature, maintain the time within ±5 seconds and the temperature within ±0.2°C (±0.3°F). If possible, keep transfer times to 30 seconds or less.
† F = Filtration
R = Recirculation
‡ Use KODAK Defoamer, Process E-6, to control foaming, if necessary. Do not splash or drip defoamer into the processing solutions; it can cause grease spots on transparencies.
J One 2-second burst with and 8-second rest. See "Improving Film Uniformity in Rack-and-Tank Processors," on page 8-4.

TIME AND TEMPERATURE

Adjust the developer times and temperatures until the densities of your KODAK Control Strips, Process E-6, plot within the control limits. **Do not** exceed the ranges given in Table 8-1. If you do not need to adjust your time or temperature, use the midpoint of the ranges; 6 minutes at 38°C (100.4°F) for both developers. Once you have selected your time and temperature, keep them within the following tolerances:

First Developer	Color Developer
Time: ±5 seconds	Time: ±5 seconds
Temperature: ±0.2°C (±0.3°F)	Temperature: ±0.3°C (±0.5°F)

RECIRCULATION

Recirculate and filter the first and color developers, bleach, and fixer to remove any dirt; even small particles of dirt can cause abrasions on the film. Recirculation also provides more uniform temperature in the developers. Recirculate the reversal bath, pre-bleach, and final rinse *only as needed.* For more information on recirculation and filtration, see section 3, “Monitoring and Controlling Processing Solutions.”

For the bleach pumps, piping, and filter container, use Type 316 stainless steel or PVC materials. For any equipment that comes in contact with the fixer, use PVC or titanium. **Do not** use copper or brass with any processing solutions.

AGITATION

Use humidified nitrogen for agitation in both developers, and air for agitation in the bleach, fixer, and washes. Use enough pressure to raise the solution level 1.5 cm (⅝ inch) with a 2-second burst. The pressure should provide vigorous bursts that cover all areas of the tank in a uniform pattern without splashing. **Do not** use agitation in the reversal bath, pre-bleach, or final rinse.

Use oil-free air for bleach agitation. Aerating the bleach reactivates it and allows you to use a very low replenishment rate. Agitating the fixer with air will aerate any bleach carried into the fixer. To minimize oxidation in the fixer, use agitation only while film is in the fixer.

REPLENISHMENT RATES

See Table 8-2 for the replenishment rates for rack-and-tank processors.

Table 8-2
Replenishment Rates—Rack-and-Tank Processors

Film Size	Area per Roll or Sheet (ft^2)	First and Color Developers 2,153 mL/m^2 (200 mL/ft^2)	Bleach 215 mL/m^2 (20 mL/ft^2)	Other Solutions 1,076 mL/m^2 (100 mL/ft^2)
		mL of Replenisher per Roll or Sheet		
135-24	0.395	79.0	7.9	39.5
135-36	0.556	111.0	11.1	55.6
120	0.550	110.0	11.0	55.0
220	1.090	218.0	21.8	109.0
4 x 5-in. sheets	0.134	27.0	2.7	13.4
5 x 7-in. sheets	0.238	48.0	4.8	23.8
8 x 10-in. sheets	0.549	110.0	11.0	54.9
11 x 14-in. sheets	1.064	213.0	21.3	106.4

Note: Wash rates are 7.5 L/min (2 gal/min).

Calculating Average Replenishment Rate per Rack: To calculate the volume of replenisher for each rack, add the amount of replenisher required for each roll or sheet on the rack. For example, for a rack that holds three 8 x 10-inch sheets, the amount of first and color developer replenisher required would be 330 mL.

If your film sizes or amount of film vary from rack to rack, determine the replenisher volume for the average rack. Keep a record of film sizes and amount of film processed to make your calculations. An example is given in the chart below.

First determine the total rolls or sheets of each film size processed over a typical time period (B). Then calculate the total square feet of each size by multiplying the total rolls or sheets by the square feet per roll or sheet (A x B = C). Keep track of the number of racks used during this time (column D). Add the total square feet of all the different sizes (column C). Add the total number of racks used (total of column D). Now divide the total square feet processed (total of column C) by the total number of racks used (total of column D). This gives you the average square feet per rack. Use that value to obtain a replenishment rate for the average rack by multiplying that figure by the replenishment rate in millilitres per square foot given in Table 8-2.

Film Size	A	B	C	D
	Area per Roll or Sheet (ft^2)	Number of Rolls or Sheets Processed	Square Feet of Film Processed	Number of Racks
135-24	0.395	100	39.5	20
135-36	0.556	100	55.6	20
120	0.550	100	55.0	33
220	1.090	100	109.0	33
4 x 5-in. sheets	0.134	100	13.4	13
5 x 7-in. sheets	0.238	100	23.8	20
8 x 10-in. sheets	0.549	100	54.9	50
11 x 14-in. sheets	1.064	100	106.0	50
Total			457.2	239

$$\text{Average square foot per rack} = \frac{\text{F (square feet of film processed}}{\text{R (number of racks)}} = \frac{457.2}{239} = 1.91$$

Solution	Replenishment (mL/ft^2 x Avg ft^2 per Rack = mL per Rack)
Developers	200 x 1.91 = 382
Bleach	20 x 1.91 = 38.2
Other Solutions	100 x 1.91 = 191

FINAL WASH

Use two 2-minute countercurrent-flow washes for the final wash. However, you can use a single 4-minute wash if it is well agitated and has a water-flow rate of 80 L/m^2 (2 gal/ft^2).

IMPROVING FILM UNIFORMITY IN RACK-AND-TANK PROCESSORS

With some rack-and-tank processors, you may have problems with film uniformity, such as occasional streaking, mottling, and spotting. Some causes of nonuniformity in rack-and-tank processors and suggestions for avoiding them are described in this section.

Testing Your Processor for Uniformity: To test processor uniformity, prepare sheets of test film. Expose 8 x 10-inch sheets of KODAK PROFESSIONAL EKTACHROME Duplicating Film EDUPE with an enlarger. Adjust the enlarger so that the light on the easel is out of focus. Use your normal filter pack for duplicating film and a 0.50 neutral density filter. Expose the film at the exposure time that you use to produce duplicate transparencies.

To determine if the nonuniformity occurs during handling or processing, process the test sheets. Orient the sheets alternately at a 90-degree angle to each other when you process them. If nonuniformity occurs *in a different position in each sheet*, check your preprocess handling. If nonuniformity occurs *in the same position in each sheet*, check your processor and/or processing conditions.

Nonuniformity from Preprocess Handling

Storage, handling, and exposure before processing can all affect uniformity in the film. A summary of possible causes of nonuniformity from preprocess handling is given below (Table 8-3).

Table 8-3
Causes of Nonuniformity from Preprocess Handling

Film Nonuniformity	Cause
Light-fog patterns	Malfunctioning shutter
	Pinholes in storage container or exposing equipment
	Instrument indicator light
	Loose packaging, not carefully sealed
	Darkroom light leaks
	Fluorescent tape, cat's-eye buttons, or instrument panel lights
Edge effects (density or color balance variation)	Film curled during exposure
	Frequent thawing and re-freezing of an opened film package
Static spots	Rapid separation of films from another surface, such as a roller, a platen, or another sheet of film
Light spots	Metallic dust in film-handling equipment
	Chemical dust
	Processing solution or water splash
Mottle or rundown streaks	Condensation

Nonuniformity from Processing Equipment and Processing Solutions

Film Clips and Springs—Some racks retain processing chemicals in the film clips or springs. The trapped solution can run down the film and leave a streak.

Cross Bars—Sometimes solution splashes occur because of the design of the rack. Solution can drip on the wide cross bars, and splash onto adjacent rolls, causing spots and streaks. This occurs particularly when two racks are crossing over at the same time, or if the racks swing during a crossover. You can check for splashing by holding a piece of white paper close to a rack during a crossover.

To control splashing—

- Use splash guards between tanks; make them as high as possible without interfering with the transfer.
- Load the emulsion side toward the dryer so if splashing occurs, it is more likely to be on the base side of the film rather than the emulsion side.
- Skip every other rack position to reduce the possibility of splashing on the film.

Wide Reinforcer Bar—Some racks are constructed with wide reinforcer bars on the bottom. If the bars are too wide, they can keep the nitrogen bubbles from agitating the solution on the film and cause streaks and mottle. To correct the problem, modify the bar or load the film so that the emulsion side is directly in the bubble path.

Agitation—Proper agitation in the first and color developers greatly affects film uniformity. If the agitation does not remove the developer by-products from the emulsion and supply fresh developer to the surface, nonuniformity can result. Lack of agitation in the first developer can cause mottle. In the color developer, the reversal bath must be removed quickly and evenly from the emulsion so that normal development can take place.

Uniform agitation is important in the first wash to remove the first developer and its by-products. Lack of agitation in the first wash can cause red streaks.

Adjust the gaseous-burst agitation in the developers and first wash so that these conditions exist—

- Adjust the gas pressure and volume so that the burst raises the solution level about 1.5 cm (⅝ inch). Pressure that is too high can cause the film to tangle, and can also cause foaming. In large tanks, a solution level rise of less than 1.5 cm (⅝ inch) may be adequate. If you cannot maintain adequate pressure, check the gaseous-burst systems for leaks. Without positive pressure, solution can back up into the line and cause a weak initial burst.
- Check that the gas is distributed evenly over all positions of the film rack. Be sure that the sparger holes are clean and that they are level across the bottom of the tank. Plugged sparger holes reduce agitation and produce patterns that cause nonuniformity. Introduce the gas into the bottom of the tank. Use humidified nitrogen to reduce the chance of plugging.
- Use a burst that lasts for 2 seconds at 8-second intervals. A shorter burst or a longer interval is inefficient. A longer burst or shorter interval in the first developer can produce nonuniformity in the film and foaming in the solution.
- Time the burst so that is occurs as soon as possible after the film enters the tank. This is especially important in the color developer. With some processors, the initial burst must be delayed so that the agitation does not move the film or rack as it enters the developer. Adjust the timing of the burst to reach the best compromise between the start of the burst and the movement of the film or rack.

Other Process-Related Conditions to Check

Recirculation in the Developers—Proper recirculation is important to maintain uniform tank temperature and to provide uniform chemical distribution. Poor recirculation can cause temperature variations in a tank that result in nonuniform development or inconsistent development within a rack or across a tank. Check that the recirculation filters are not plugged. **Do not** use a filter finer than 10 microns.

Slow Transport Speed—Immersing the film into the color developer too slowly produces a vertical pattern and may delay the initial agitation burst. When this occurs, streaking may be more severe on the sheets at the bottom of the rack than those at the top.

Agitation for Push Processing—Extend the first-developer time in such a manner that it does not affect the agitation in subsequent processing solutions/steps.

Developer Replenishment—Exhausted first or color developer may cause mottle and produce unacceptable results.

Foaming—Excessive foaming in the first and color developers can cause nonuniformity. Use KODAK Defoamer, Process E-6, to control foaming in the first-developer, color-developer, and bleach tanks; **do not** use defoamer in the final-rinse tanks (it can leave oily deposits on the film). Apply a thin layer of defoamer to the inside of the process tank above the solution level. *Use the defoamer sparingly*. **Do not** add defoamer directly to the tank solution.

SILVER RECOVERY

You can recover silver from used fixer or fixer overflow by collecting the solution, and then passing it through a KODAK Chemical Recovery Cartridge, Junior Model II (3½-gallon size, CAT No. 166 9431), a KODAK Chemical Recovery Cartridge, Model II (5-gallon size, CAT No. 173 4953), or an equivalent cartridge.