Manual Processing of INDUSTREX Films

To reach the desired optical density on a radiograph while achieving optimal radiographic image quality, it is important to follow recommended processing conditions and to use proper exposure (dose) for the selected film type and for the object being examined. Film characteristic curves can be used to:

- Adjust the X-ray exposure that is used to produce a radiograph with a certain optical density to an exposure that will produce a second radiograph of higher optical density.
- Relate the X-ray exposure produced with one film to the exposure needed to produce a radiograph of the same density with another radiographic film.

When using a Gamma source, you can use the INDUSTREX Film R-Factor Table to determine the correct exposure (based upon density desired – see the table on page 7). By removing the processing variable, you can get better consistency and higher productivity in the darkroom. INDUSTREX Films incorporating T-grain emulsion technology provide stable contrast and a relatively stable speed over a wider range of developer temperatures—unlike older film technologies that have highly variable speed, relative to developer temperature and immersion time.

NOTE: See CHSP-8970, *Automatic Processing of INDUSTREX Films,* for details regarding automatic processing.

Timer and Thermometer

The timer and the thermometer are essential. They must be accurate and in good condition. Avoid adjusting development time ("sight developing") to compensate for under- or over-exposed images.

Safelight Filter

The darkroom must have suitable safelight illumination.

Use a red safelight filter, such as GBX-2, with a frosted 15-watt bulb or a LED Safelight (660 nm peak) located at least 1.22 m (48 in.) from the film.

NOTE: Other safelight filters that block radiation at 550 nm and shorter wavelengths are also suitable.

Film Handling

Hands must be clean, dry, and free of lotions. Do not bend the film. Handle the film only by the edges to avoid finger marks and abrasions when loading on hangers. Hangers must also be clean and dry. Separate hangers in the solutions so that the films will not touch each other or the tank wall.

Recommended Chemicals

Processing

INDUSTREX Single Part Developer Replenisher is optimized for manual and automatic processing.

Stop Bath

Use a stop bath to check development. A stop bath rapidly prevents most spotting or streaking and prolongs the life of the fixing bath. Use a stop bath mixed at a 3 % solution (for example, 28 % acetic acid at 110 mL/L) for 30 seconds.

NOTE: A running water rinse for one minute may be substituted for a stop bath. However, it may not provide results equivalent to a stop-bath solution.

Fixer

Use a fixer solution such as INDUSTREX LO Fixer and Replenisher.

Final Rinse

Use a rinse solution/wetting agent to reduce water spots and drying marks on film.

Replenishment Rates

NOTE: Observe precautionary information on product labels and Material Safety Data Sheets.

Maintain the chemical activity and solution level in the tank by topping off the developer and fixer tanks daily or every 25 sheets (whichever occurs first). Stir solutions after each addition. Follow the manufacturer's instructions for the specific developer replenisher and fixer replenisher.

Also:

- When removing films from a developer tank, DO NOT ALLOW THE EXCESS SOLUTION TO DRAIN BACK INTO THE TANK. Normally, this will carry out the proper amount of solution for correct replenishment.
- Use floating covers on the developer tanks to reduce oxidation and evaporation. Store developer replenisher in a closed airtight container.
- Fill the developer and fixer tank to its original level each morning with developer or fixer replenisher solution. Periodically top off as necessary throughout the workday.
- Discard solution after adding two tank volumes of replenisher to the tank, or at least once per month, and then refill with fresh solution.
- Dry in a dust-free area at room temperature or in a suitable drying cabinet. Temperature in the drying area is not to exceed 50 °C (120 °F).

Manual Processing Development

Temperature	Development Time (Mins)	Stop Bath	Fixer	Wash
20 °C (68 °F)	5	30–60 seconds (Continuous moderate agitation)	3–6 mins or twice the time to clear film (Vigorous agitation for 15 seconds, then 5 seconds every 30 seconds)	10–30 mins in running water (8 volume changes per hour)
22 °C (72 °F)	4			
24 °C (75 °F)	3			
26 °C (79 °F)	2			

Stop, Fix and Wash Steps

	Temperature	Recommended Time	Agitation
Indicator stop bath, diluted 3.5% solution, or running water rinse	16–30 °C (60–85 °F)	30 seconds	Moderate
INDUSTREX LO Fixer and Replenisher	16–30 °C (60–85 °F)	3–6 minutes, or twice the clearing time	Vigorous for 15 seconds, then intermittent (5 seconds) every 30 seconds)
Running water wash (8 volume changes per hour)	16–30 °C (60–85 °F)	10–30 minutes	

NOTES:

- If it is necessary to process film at temperatures around 24 °C (75 °F) and higher, then the fixer solution should be renewed frequently. Fix the film to provide maximum hardening and limit the washing time to 15 minutes.
- A rinsing (wetting) solution is recommended after washing to reduce water spots and drying marks.
- A stop bath checks development, prevents most spots and streaks, and prolongs the life of the fixing bath.

Ensuring Process Quality

Residual Thiosulfate Test

Use a test kit to ensure good life expectancy (LE) characteristics for radiographs. A test such as the X-OMAT Hypo Estimator Test Kit (CAT 196 5847) determines whether film has been adequately washed and provides an estimate of the archival life you can expect. The kit comes with testing solution, eyedropper, instructions for use, and a visual Hypo Estimator.

Residual Silver Test Solution

An overworked fixing bath contains complex silver thiosulfate compounds that cannot be removed completely by washing. A residual silver test solution provides a quick and accurate method for determining when a fixing bath should be discarded. Prepare the test solution as follows:

Water	100 mL
Sodium Sulfide (Anhydrous)	2 g

To Use: Store stock solution in a small stoppered bottle for no longer than three months. Dilute one part stock solution with nine parts water. (Replace the working solution weekly.) Place a drop of the test solution on the margin of the processed film. Remove solution after 2–3 minutes. Any yellowing of the test area indicates the presence of silver. Refix the film in fresh fixer and rewash. The yellow stain is permanent.

Fixer Test Solution

A fixer test solution is used to check the silver content of the fixer bath. Prepare the test solution as follows:

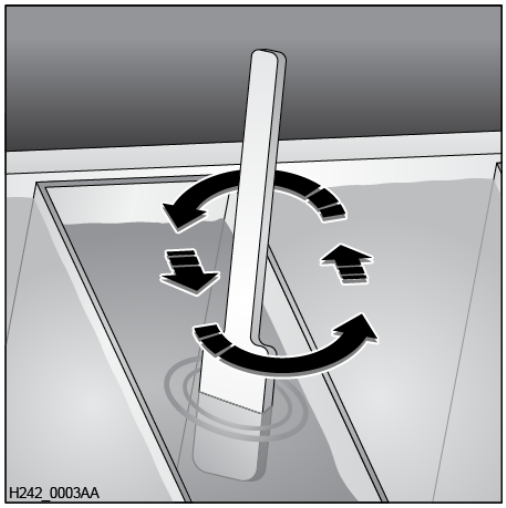
Water at 27 °C (80 °F)	750 mL
Potassium Iodide	190 g
Water to make	1 L

To five drops of the test solution, add five drops of the fixing bath and five drops of water. Discard the fixer if a yellow-white precipitate forms instantly. (You can disregard any slight milkiness.)

You can also use silver estimating test papers to measure the silver content in your fixer.

Step-by-Step Guide to Manually Processing INDUSTREX Films

1-Stir Solutions

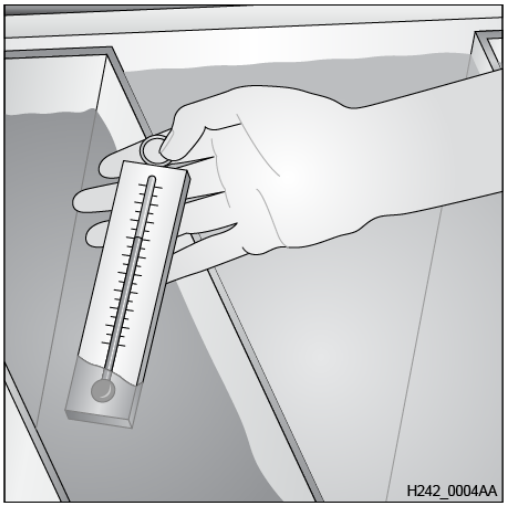


Stir the developer and fixer to equalize their temperatures.

Use separate paddles for each to avoid contamination.

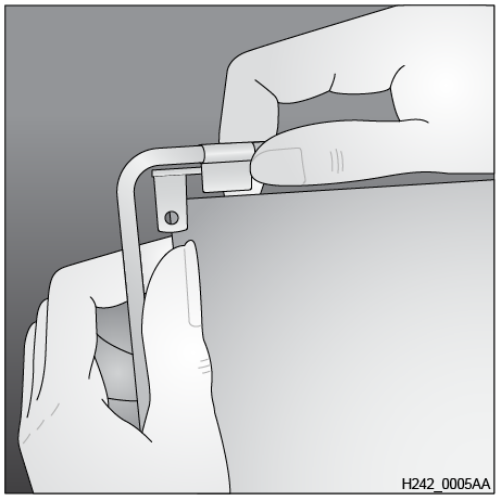
NOTE: Small amounts of fixer will contaminate developer and make it unusable.

2-Check Temperature



Check the temperature of the solutions with an accurate thermometer, rinsing it off after checking each one. Adjust the temperature as needed.

3-Load Film on Hanger

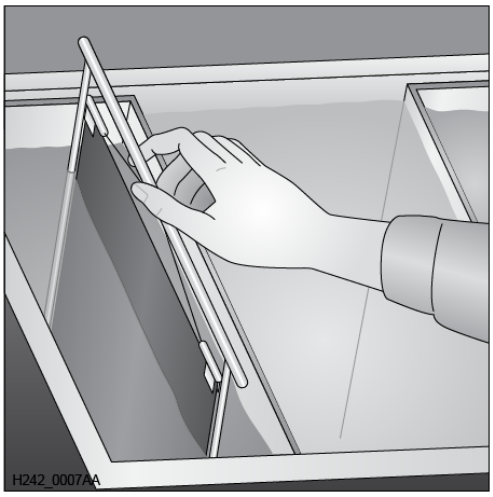


Attach the film carefully to a proper-sized hanger. Attach the lower corners first. Avoid finger marks, scratches or bending.

4-Set Timer for Developing

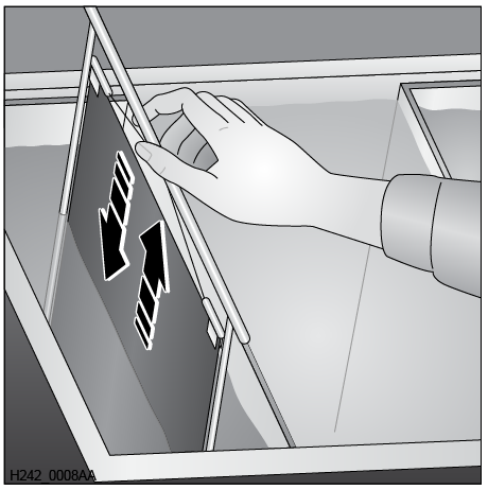
Set a timer for 4 minutes at 22 °C (72 °F). See time temperature table on page 2 for the equivalent cycle.

5-Immmerse Film in Developer



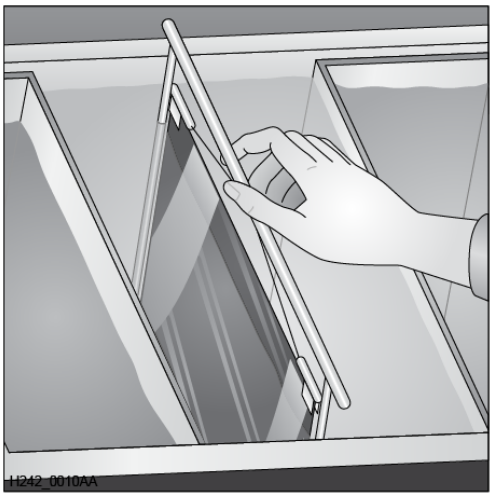
To avoid streaking, completely immerse the film smoothly and without pausing. Start the timer.

6-Agitate Film



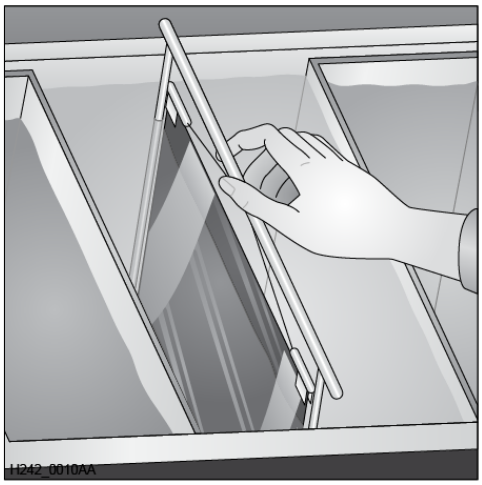
Immediately after immersion in the developer, tap the hanger to dislodge air bubbles. Do not agitate further.

7-Immerse in Stop Bath



When the timer ends, place the film in the stop bath for 30 seconds. Agitating moderately, lift from the stop bath and drain well.

8-Fix Adequately

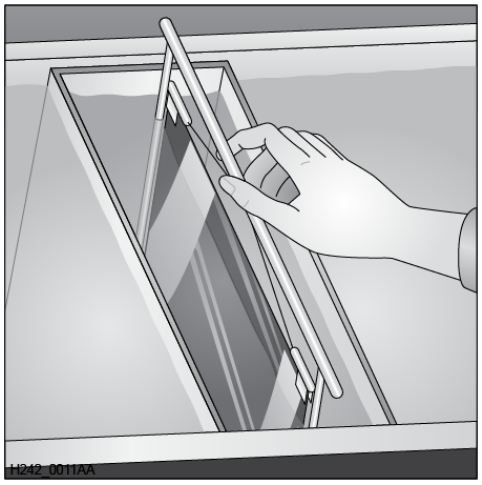


Immerse the film in the fixer for **3-6 minutes**, agitating for **5 seconds every 30 seconds**. Film should remain in fixer for twice the time it takes to "clear" it (when the milky look disappears).
Never fix film for less than 3 minutes.

9-Wash Completely

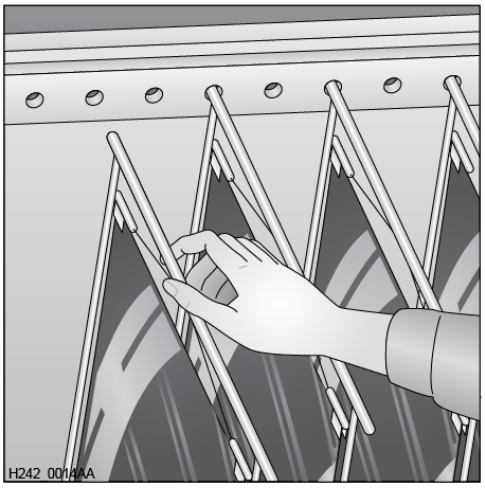
Place the film hangers in a tank of running water for **10–30 minutes**. Keep ample space between the hangers (water must flow over the top).

10-Final Rinse



If facilities permit, use a final rinse with a rinsing (wetting) agent to speed drying and prevent water marks. Immerse film for about 30 seconds, and then drain for several seconds.

11-Place in Dryer



Dry the film at room temperature in a dust-free area or suitable drying cabinet. The temperature must not exceed 49 °C (120 °F). When the film is dry, remove from hangers and insert into envelopes.

INDUSTREX Film R-Factor Table

Reference the table to determine the correct exposure, based on desired density:

		Desired Densities: 2	2.5	3	3.5
Selenium	M100	3.6	4.6	5.5	6.5
	MX125	2.2	2.9	3.6	4.4
	T200	1.4	1.8	2.2	2.6
	AA400	0.8	1.2	1.6	2
	HS800	0.3	0.6	0.8	1
Iridium	M100	3.2	4.3	5.5	6.6
	MX125	2.3	3.1	3.9	4.7
	T200	1.1	1.5	2	2.4
	AA400	0.8	1.1	1.5	1.9
	HS800	0.2	0.5	0.7	0.9
Cobalt	M100	7.3	9.3	11.4	13.4
	MX125	3.9	5.3	6.7	7.9
	T200	2.3	3.1	3.9	4.7
	AA400	1.2	1.8	2.4	2.9
	HS800	0.1	0.6	1	1.4

NOTE: The data in this publication does not represent standards that must be met by Carestream. The company reserves the right to change and improve product characteristics at any time. The contents of this publication are subject to change without notice.

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Rev 3, Mar 2021: Deleted the step from the manual process to drain the film after the developer/before the stop bath. Draining is not beneficial to this step of the process.

Rev D, Jun 2021: Minor updates. First release into PLI (uses letter versioning).