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 will 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

Use INDUSTREX Single Part Developer Replenisher or INDUSTREX Manual Developer.

NOTE: Although optimized for automatic processing, the improved Single Part Developer Replenisher can be used for manual processing. However, optimal manual processing performance is obtained with the INDUSTREX Manual Developer Kit and Fixer Kit.

Stop Bath

Use a stop bath to check development—rapidly preventing most spotting or streaking—and prolong the life of the fixing bath.

INDUSTREX Manual Stop Bath (Single-part concentrate diluted 1+19 w/H2O): This odorless stop bath features an indicator that changes color (from orange-yellow to magenta-red) at pH 5.2 to alert the user of declining activity, so that the solution can be changed or additional concentrate added.

Any acetic acid stop bath mixed at a 3 % solution (for example, 28 % acetic acid at 110 mL/L) for 30 seconds can also be used.

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

Fixer

Use a fixer and replenisher solution, such as INDUSTREX LO Fixer and Replenisher or INDUSTREX Manual Fixer and Replenisher.

Final Rinse

INDUSTREX Manual Rinse Solution (Single-part concentrate diluted 1+19 w/H2O): This solution is a wetting agent that effectively reduces 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)	Acetic Acid 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% acetic acid 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. The film should be fixed to provide maximum hardening and the washing time should be limited to 15 minutes.
- A Hypo Clearing Agent can be used following the fixer to reduce wash times and conserve water. First rinse films in running water for 30 seconds, then use Hypo Clearing Agent for 1-2 minutes, followed by a final running water wash for 5 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 complete 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 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:

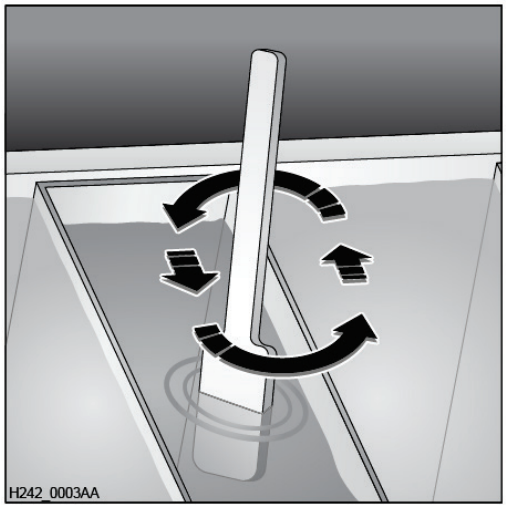
Water at 27 °C (80 °F)	750 mL
Potassium Iodide	190 g
Water to make	1 L

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

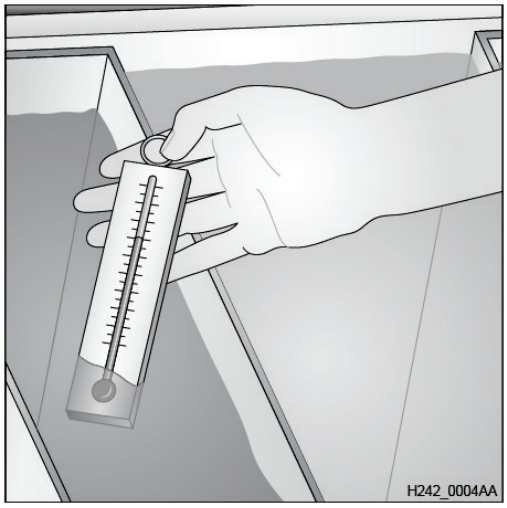


Stir the developer and fixer to equalize their temperatures.

Use separate paddles for each to avoid contamination.

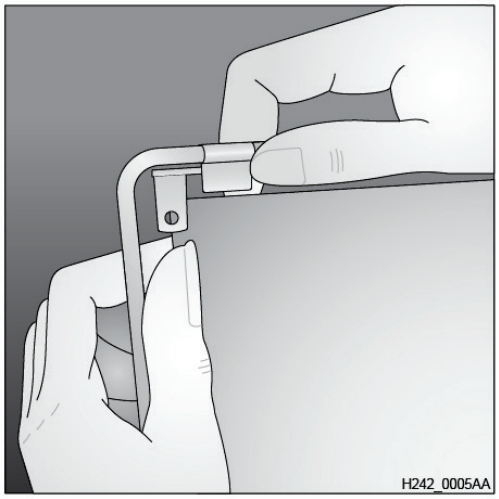
NOTE: Small amounts of fixer will contaminate developer and make it unusable.

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

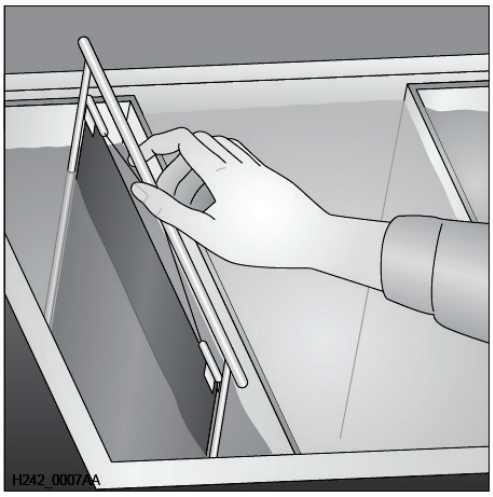


Attach the film carefully to a proper-sized hanger. Attach the lower corners first. Avoid finger marks, scratches or bending.

4-Set Timer for Developing

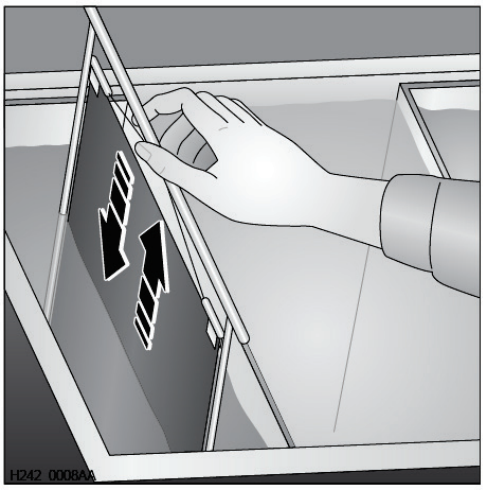
Set a timer for 4 minutes at 22 °C (72 °F). See time temperature table on the last page for the equivalent cycle.

5-Immmerse Film in Developer



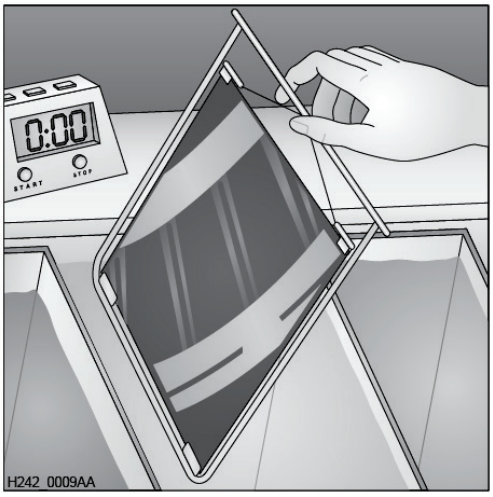
To avoid streaking, completely immerse the film smoothly and without pausing. Start the timer.

6-Agitate Film



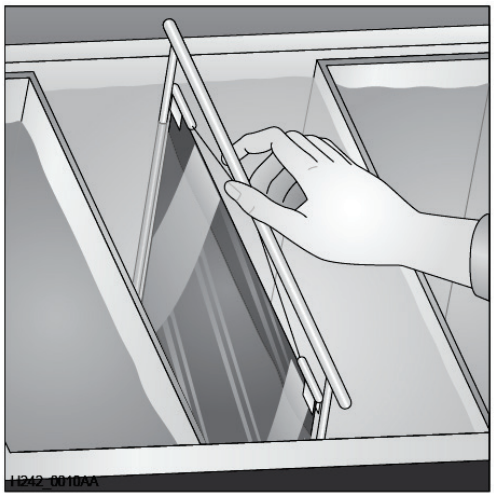
Immediately after immersion in the developer, tap the hanger to dislodge air bubbles. Do not agitate further.

7-Drain (Outside Developer)



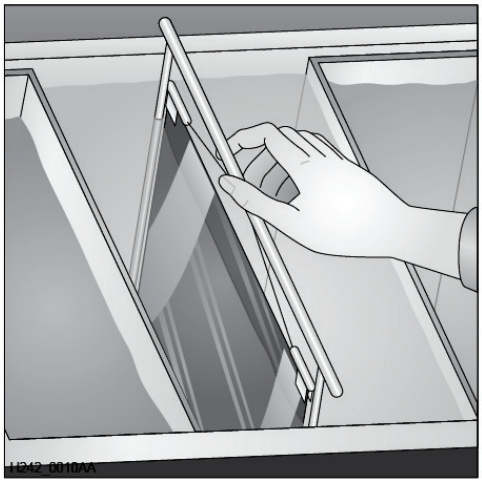
When the timer goes off, quickly lift the hanger out of the developer. Then drain the film **for a moment** into the space between the tanks. For faster drainage, tilt the hanger.

8-Immerse in Stop Bath



Place the film in the stop bath for 30 seconds. Agitating moderately, lift from the stop bath and drain well.

9-Fix Adequately

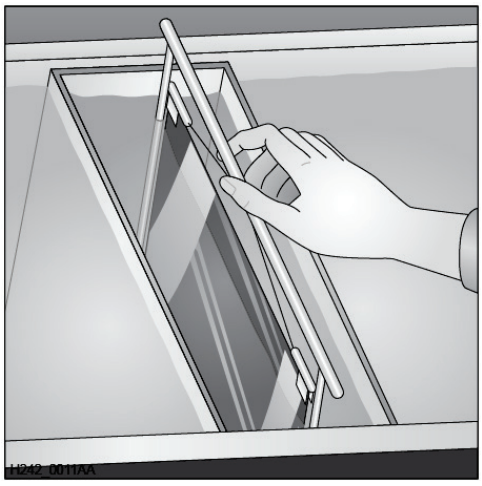


Immerse the film in the fixer for **3-6 minutes**, agitating for **5 seconds every 30 seconds**. Film should remain in fixer for twice the time it takes to "clear" it (when the milky look disappears). **Never fix film for less than 3 minutes.**

10-Wash Completely

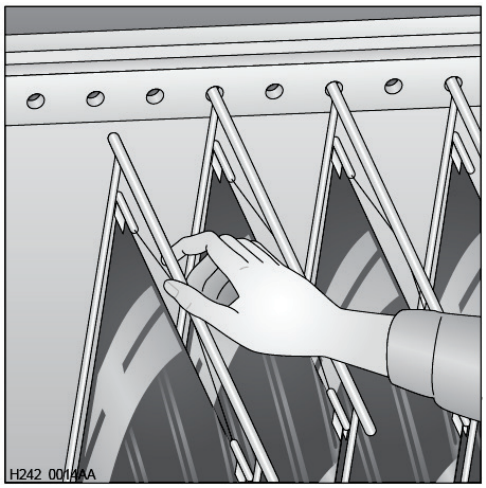
Place the film hangers in a tank of running water for **10-30 minutes**. Keep ample space between the hangers (water must flow over the top).

11-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.

12-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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Publication History:

Previous releases: TI-2643, Feb 2012, May 2013.

May 2020: Technical updates. Created in TI DB with new CHSP number.

Automatic Processing of INDUSTREX Films

INDUSTREX Single Part Developer Replenisher

This formula is a universal, single-part concentrate used to process all types of non-destructive testing film. This liquid concentrate provides easy mixing, is compatible with existing automatic processing cycles of 8 minutes and longer, and allows a shorter processing cycle (5 minutes) for all films. The developer replenisher is designed for use in both automatic and manual processing and with all INDUSTREX Films.

This formula allows high photographic consistency and quality, and ensures efficiency when using a low replenishment rate. It also reduces any environmental impact, and reduces or minimizes operator maintenance due to crystallization, silver deposits, or sludge.

NOTE: See CHSP-8971, *Manual Processing of INDUSTREX Films,* for details regarding manual processing.

Features:

- High chemical stability—includes consistent image quality over an extended period of time, excellent resistance to aerial oxidation, and low sludge formation
- Minimal packaging, less solid waste
- Glutaraldehyde free
- Strengthened "activation power." High activity allows for fast processing and high productivity
- Outstanding image quality—cold (blue) image "tone" and low granularity
- Low environmental impact—low COD and BOD5 (5-days Biochemical Oxygen Demand)
- Concentrated (single part) liquid developer provides ease of use
- Can be used in chemical auto-mixers

INDUSTREX LO Fixer and Replenisher

This fixer is recommended to process all types of industrial imaging film in automatic and manual processing cycles. This formula consists of a single-part liquid—just add water to the proper dilution. For use, dilute the concentrate with water according to the instructions on the packaging.

You can use the INDUSTREX LO Fixer and Replenisher with all INDUSTREX Films.

Features:

- Low odor
- Good radiograph life expectancy (LE)
- Low environmental impact—low COD and BOD5 (5-days Biochemical Oxygen Demand)
- Can be used in chemical auto-mixers

Storing Solutions

To maintain product quality, these chemicals must be stored in the original unopened package, at a temperature between 5-30 °C (41-86 °F). When stored in these conditions, the lifetime is two years from the date of manufacture. Discard solutions if there is evidence of contamination, dirt, over-dilution, excessive evaporation, or crystallization.

Mixing Instructions

INDUSTREX Single Part Developer Replenisher

INDUSTREX Single Part Developer Replenisher is supplied in a quantity to prepare 38 L (2 x 19 L) or 40 L (2 x 20 L) of working solution, depending on geographic region, and consists of recyclable polyethylene containers of concentrated developer solution.

Mixing the Developer Replenisher

To Make Working Strength Solution	Start with Water at 10–30 °C (50–86 °F)	Add Concentrate (Number of Bottles)	Fill to:	Stir
19 L	10 L	1	19 L	Stir for about two minutes until a completely homogeneous solution is obtained.
20 L	10 L	1	20 L	

To mix smaller quantities, use the following table and multiply as needed:

To Make 1 L Working Strength Developer Solution:		
Start with Developer Concentrate	**Add Water at 10–30 °C (50–86 °F) to make 1 L**	**Stir**
250 mL	750 mL	Stir for about two minutes until a completely homogeneous solution is obtained.

Auto-mixer Mixing

Remove the bottle caps (leaving the seal intact) and place the bottles in the auto-mixer template. The auto-mixer will add water to achieve the proper volume or specific gravity, depending on the type/model of auto-mixer. See the packaging for details.

INDUSTREX Single Part Developer Starter

It is recommended to use the INDUSTREX Single Part Developer Starter with the INDUSTREX Single Part Developer Replenisher to prepare a developer working-strength startup solution for automatic processing.

Add 31 mL of starter solution per 1 L of the mixed INDUSTREX Single Part Developer Replenisher tank solution.

Developer Tank Sizes/Starter Volume

INDUSTREX Processor	Developer Tank Volume (L)	Starter Amount (31 mL/L), CAT 835 1413
M43	13.5	418.5
M37	6.5	201.5
M37 Plus	7.5	232.5

INDUSTREX LO Fixer and Replenisher

INDUSTREX LO Fixer and Replenisher is supplied in a quantity to prepare 38 L (2 x 19 L) or 40 L (2 x 20 L) of working solution, depending on geographic region, and consists of recyclable polyethylene containers of concentrated developer solution.

To Make Working Strength Solution	Start with Water at 10–30 °C (50–86 °F)	Add Concentrate (Number of Bottles), Stirring Constantly	Fill to:	Stir
19 L	10 L	1	19 L	Stir for about two minutes until a completely homogeneous solution is obtained.
20 L	10 L	1	20 L	

To mix smaller quantities, use the following table and multiply as needed:

To Make 1 L Working Strength Fixer Solution:			
Start with the Package that Makes:	**Start with Fixer Concentrate**	**Add Water at 10–30 °C (50–86 °F) to Make 1 L**	**Stir**
19 L	200 mL	800 mL	Stir for about two minutes until a completely homogeneous solution is obtained.
20 L	250 mL	750 mL	

Auto-mixer Mixing

Remove the bottle caps (leaving the seal intact) and place the bottles in the auto-mixer template. The auto-mixer will add water to achieve the proper volume or a specific gravity, depending on the type/model of the auto-mixer. See the packaging for details.

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.

Automatic Processing

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

Cycle	Time (Minutes)	Development Time (Seconds)	Temperature
M37 Plus Processor			
Normal	8	110	28 °C (82 °F)
Short	6	90	30.5 °C (90 °F)
M43ic Processor			
Normal	8	100	26 °C (79 °F)
Short	5	70	30 °C (86 °F)

Washing

Use a filtered water supply of proper water temperature, pressure and flow. Follow the processor manufacturer's recommendation for wash flow rate.

NOTES:

- Insufficient wash flow can adversely affect the life expectancy of processed radiographs. For best results, and to prevent development of bio-slime/algae, drain the wash tank daily and leave it empty when not in use.
- Proper installation is a critical component to the success of any processor. Benefits of proper installation include:
    - Film and image quality
    - Increased productivity, e.g. less time spent on repairs
- Refer to the INDUSTREX Processor Site Specifications, especially the environmental requirements.

Drying

Follow the processor manufacturer's recommendation for dryer settings. In general, the dryer should be set to a temperature slightly above the lowest temperature required to eliminate any signs of tackiness in films exiting the dryer (3 °C/5 °F).

Replenishment

The consistency of the radiographic quality is related to the accurate adjustment of the replenishment rate. Replenishment should maintain the chemical equilibrium, replacing the components used by the film.

Replenishment Volume

Solution	Per 35 x 43 cm (14 x 17 in.) Sheet	Per m^2
Developer	100 mL	665 mL
Fixer	180 mL*	1200 mL*

*For optimum radiograph life expectancy (LE), a 10 % increase in fixer replenishment rate may be desirable.

Control of the Processing System

The processing system can be controlled by use of certified pre-exposed control strips as specified in EN ISO 11699-2 and/or ASTM E999.

NOTE: See CHSP-8983, *Using INDUSTREX Process Control Strips*, for more information.

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 complete with testing solution, eyedropper, instructions for use, and a visual Hypo Estimator.

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