

ILFORD FP4 *Plus* PROCESS CONTROL STRIPS & FILM PROCESS CONTROL

METHODS AND TECHNIQUES TO MONITOR THE PERFORMANCE OF BLACK AND WHITE FILM PROCESSING SYSTEMS

To process black and white films to a consistently high standard, it is essential to use an independent, measurable method of monitoring the condition and activity of the processing solutions.

The ILFORD FPC (Film Process Control) system is a way of monitoring the state of ILFORD replenishable film developers. This fact sheet gives the detailed information needed to apply the ILFORD FPC system of process control to ILFORD ILFOTEC DD developer and ILFORD DD starter, ILFOTEC RT Rapid Developer and ILFOTEC RT Rapid starter, ILFOTEC HC developer and ILFOTEC HC replenisher and ILFORD ID-11 developer and ILFORD ID-11 replenisher. It can also be applied to the replenished developers supplied by other manufacturers.

To monitor your process you need:

- 1 ILFORD FP4 Plus PROCESS CONTROL STRIPS.
- 2 ILFORD FPC process control charts
- 3 A densitometer to measure the density of the control strip patches.
- 4 ILFORD FPC information.
- 5 ILFORD FPC PROCESS CONTROL FAULT FINDER GUIDE
- 6 Thermometer
- 7 pH meter or pH measurement sticks

8 Hydrometer

ILFORD FP4 Plus PROCESS CONTROL STRIPS

Description

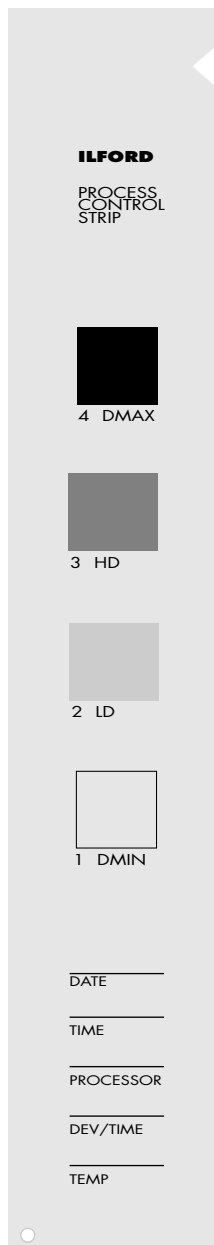
ILFORD FP4 Plus PROCESS CONTROL STRIPS are specifically designed for process control. They are pre-exposed strips of standard FP4 Plus 35mm film used to monitor the activity of black and white developer solutions. They are suitable for use with all mechanical black and white film processing systems that use solution tanks, such as, dip & dunk (hanger), roller transport, short leader and continuous processors and also can be used with manual deep tank systems.

When processed FP4 Plus PROCESS CONTROL STRIPS show an identification mark "ILFORD PROCESS CONTROL STRIP", density patches in four steps for measurement purposes and places to note the date, time, processor, development time and temperature. The four density patches are numbered and marked, 1, Dmin, (minimum density), 2, LD (low density), 3, HD (high density) and 4, Dmax (maximum density).

LD and HD, patches 2 and 3, are the ones mainly used for process control purposes. LD and HD-LD values are plotted on the PROCESS CONTROL CHART and are used to monitor the process.

Dmin and Dmax, patches 1 and 4, are used for the diagnosis of problems. The minimum density, Dmin, is a measurement of the control strip's base density and fog due to development. Variations in the minimum density can help to identify trends when the LD and HD-LD graphs show there is a problem. Dmax is often too variable to identify trends and is not plotted for process control purposes, however it may be helpful to measure this value when trying to identify processing problems.

FP4 Plus PROCESS CONTROL STRIPS are supplied on 30.5m (100ft) lengths of 35mm film wound emulsion inwards (EI). Each strip is approximately 41 cm (16ins) long giving approximately 72 useable strips per roll. Notches along the film's edge and punched holes in the film are provided throughout the roll's length to enable users to identify where to cut off single strips for use. The notch and punch holes are approximately 2.5cm (1in) apart.



Handling

Handle and process FP4 Plus PROCESS CONTROL STRIPS in total darkness.

Orientation

If the user always cuts across the film between the punch hole and the notch each strip will have a notch at its top, (the end with the highest density patch), and a punch hole at its bottom, (the end with the lowest density patch). The emulsion side is towards the user when the notch is at the top right hand edge and the punch hole is at the bottom left.

Storage

For short periods of time or while they are being used, FP4 Plus PROCESS CONTROL STRIPS can be kept and stored at room temperature, 20°C (68°F), without any significant loss of performance. For storage long term we recommend that FP4 Plus PROCESS CONTROL STRIPS are kept refrigerated at a temperature below 5°C (41°F). Storage for very long time periods should be at temperatures below -18°C (0°F).

Before using the strips after refrigeration or freezing, allow them to reach room temperature before opening the packaging. The time taken for this depends on the storage temperature used and the ambient temperature to be reached. Allow the warming process to occur naturally, do not apply any form of direct heat to speed this up as it could damage the film.

ILFORD FPC PROCESS CONTROL CHARTS

Copies of the ILFORD FPC PROCESS CONTROL CHARTS and instructions for their use can be downloaded from our web site at www.ilford.com or contact your local ILFORD selling company or distributor.

ILFORD FPC information

Other ILFORD FPC information including master copies of user data sheets for recording information about; development times, solution preparation, etc. and product fact sheets, can be obtained from our web site at www.ilford.com or contact your local ILFORD selling company or distributor.

ILFORD FPC PROCESS CONTROL FAULT FINDER GUIDE

The ILFORD FPC PROCESS CONTROL FAULT FINDER GUIDE can be obtained from our web site at www.ilford.com or contact your local ILFORD selling company or distributor. The information it contains helps to explain the meaning of the data on your process control charts and is useful when trying to diagnose trends, problems and their causes.

SETTING UP YOUR PROCESSES

If you have already installed the solutions in your processor, and it is producing good quality negatives, go to the section below called 'Starting process control'.

On the other hand, if you are filling a processor with fresh processing solutions make sure you have the chemicals recommended for your type of processor. You need enough of each chemical to be able to make up the solutions to fill each of your machine's process and replenishment tanks. Refer to the information supplied by your processor's manufacturer for the quantities of the working strength solutions required and follow their recommended procedures for filling the machine with solutions and preparing it for use.

Make sure your processor is calibrated and set to give the right solution temperatures, agitation, process times and replenishment rates for the developer and other chemicals you have chosen to use.

Information about the suitability of a developer or other chemical for a particular type of processing machine can usually be obtained from the chemical supplier. For information about the suitable application of ILFORD developers and chemicals please refer to the relevant chemical fact sheets on our web site at **www.ilford.com**.

Prepare your chosen chemicals in accordance with the manufacturer's instructions.

Note: Photographic chemicals are not hazardous when used correctly. It is recommended that gloves, eye protection and an apron or overall are worn when handling and mixing all chemicals. Always follow the specific health and safety recommendations on the chemical's packaging.

Photochemical material safety data sheets containing full details for the safe handling, disposal and transportation of ILFORD chemicals are available from ILFORD agents or directly from the ILFORD web site at **www.ilford.com**.

BEFORE STARTING PROCESS CONTROL

Applying process control to a poor process only maintains poor results so before you can begin to monitor the state of your process it must be producing good results, i.e. the negatives should have good density and contrast.

Small changes to the development time or temperature will correct slightly thin or dense negatives or ones that are hard or soft in contrast, but any major problems will need corrections beyond the scope of this fact sheet. As a guide a correctly exposed and processed negative of normal contrast and density should be making a good print on a mid contrast grade of paper, grades 2 or 3.

If your film process is producing poor negatives you should check the following: developer pH and specific gravity, fixer pH and specific gravity. Information about the pH and specific gravity operating values and tolerances of your chemicals can be obtained from the manufacturer, for information about ILFORD chemicals consult the relevant fact sheet. You should also check the machine's functions; solution temperatures, agitation, replenishment rates, process times, etc. and make any necessary adjustments. If the problems are severe it usually means starting from fresh.

PROCESSING WITH REPLENISHED DEVELOPER

The effect of use on a replenished developer system

Starting from fresh solutions requires some initial management until the tank of developer becomes seasoned. The reaction that takes place during film development releases by-products (halides) into the developer, uses up developing agents and changes the developer's pH. These combine to reduce the activity of the developer and without proper replenishment the developer gradually ceases to function adequately and eventually becomes exhausted.

Replenishment has two key functions. It replaces the active ingredients used during development and dilutes the by-products that have been formed.

A replenished developer is said to be fully "seasoned" when the addition of the replenisher compensates exactly for the new by-products produced by development. At this point the concentration of halides and active ingredients have reached an equilibrium or steady state.

It is maintaining this equilibrium that gives a machine developer performance consistency. Provided that the developer is used regularly, replenishment continues and all other factors remain the same, i.e. the concentration of the active ingredients, the by-products, etc. then the developer should perform consistently for a long period of time.

Fresh versus seasoned developer and the function of starter and replenisher solutions

There are two types of replenished developer systems. One consists of a solution that acts as both the developer and the replenisher solution and has a separate "starter" solution additive that turns replenisher into developer. The other consists of a developer solution and a separate replenisher solution.

ILFORD ILFOTEC DD and ILFORD ILFOTEC RT Rapid developers are examples of developer/replenisher plus starter systems, whereas ILFORD ILFOTEC HC and ILFORD ID-11 are examples of developer plus replenisher systems.

A tank of freshly made working strength developer is usually more active than a tank of "seasoned" replenished developer. If the same process time is used in both cases then a small loss in film speed and contrast will be seen using the seasoned developer. The change in performance from fresh to seasoned is gradual with each film processed until the equilibrium point is reached.

In a developer/replenisher process system a starter solution is used to minimise the performance difference between fresh and seasoned solutions.

In a replenished process system with separate developer and replenisher solutions, the replenisher is formulated to be more active than the developer. The addition of this more active solution minimises the performance differences between the fresh and seasoned condition.

The time taken to reach equilibrium from fresh depends on a number of factors; the developer and replenisher formulae, tank size, the amount of film processed and their type and the replenishment rates used. Information specific to the ILFORD developers, ILFOTEC DD, ILFOTEC RT Rapid, ILFOTEC HC and ID-11 can be found in the relevant product fact sheets.

**STARTING PROCESS CONTROL USING FP4 Plus PROCESS CONTROL STRIPS
Preparing master strips and aim values**

If your developer is giving you the quality of negative that you require then to start a process control system you need to:

- 1 Produce master process control strips.
- 2 Calculate the aim values from these master strips to create a benchmark for your process.
- 3 Start a process control chart with these aim values.

To produce your master strips, first process three FP4 Plus PROCESS CONTROL STRIPS. Process these strips when the developer is producing satisfactory results, but not immediately after a period of inactivity, for example, a weekend.

The table below gives development times for FILM PROCESS CONTROL STRIPS in ILFORD developers at their recommended working temperatures. These development times will need some adjustment if you are operating your processor at either higher or lower temperature than the one shown. Process the FP4 Plus PROCESS CONTROL STRIPS at the time you use for FP4 Plus

Recommended development times in ILFORD replenished developers

Developer	Dilution	Temperature °C/°F	Time min:sec
ILFOTEC DD	1+4	24/75	8:30
ILFOTEC RT RAPID	1+1+2	26/78	0:45
ILFOTEC RT RAPID	1+1+5	26/78	0:65
ILFOTEC HC	1+15	22/72	4:00
ILFOTEC HC	1+31	22/72	8:00
ID-11	Stock	20/68	8:30

Fill in the first part of a new ILFORD PROCESS CONTROL CHART with the process details including development time, temperature, the date, etc.

After processing any strips measure the density of the patches using a calibrated transmission densitometer and record the results for Dmin, LD and HD. Examine the strips, a visual assessment of density cannot be relied upon for the purposes of process control but the strips should be checked for any anomalies such as dirt, debris or drying defects as this may indicate other problems.

Next tabulate the density values of the LD and HD patches of all three master strips and calculate the HD-LD values.

Example	LD (patch 2)	HD (patch 3)	HD-LD
Strips 1	0.47	1.28	0.81
Strip 2	0.49	1.29	0.80
Strip 3	0.48	1.27	0.79

Calculate the average LD value by adding the three LD figures together and dividing the result by three, = 0.48 in this example. Calculate the average HD-LD value using the same method, = 0.80 in this example. Round the result of these calculations to two decimal places, if necessary.

Enter the average LD and HD-LD values into the LD and HD - LD aim value boxes on the ILFORD process control chart (see the example chart in the "Introduction to the FPC Process Control Manual" fact sheet). In the above example this would be LD = 0.48 and HD - LD = 0.80

Typical aim values for FP4 Plus CONTROL STRIPS in ILFORD developers are shown in the table below. These are supplied as indicators of the values that can be expected from a typical process. You should not attempt to adjust your process to obtain identical values to the ones given below. It is far more important that you are satisfied with the quality of the negatives you are producing and record the control values that this gives you to use as your aim.

Typical aim values

Developer	Dilution	Dmin	LD	HD-LD
ILFOTEC DD	1+4	0.35	0.51	0.80
ILFOTEC RT RAPID	1+1+2	0.35	0.54	0.80
ILFOTEC RT RAPID	1+1+5	0.35	0.41	0.80
ILFOTEC HC	1+15	0.30	0.45	0.80
ILFOTEC HC	1+31	0.30	0.45	0.80
ID-11	Stock	0.35	0.45	0.80

Plotting process control values and tolerances

FP4 Plus CONTROL STRIPS should be regularly processed at the development time you usually use for FP4 Plus film. The frequency of processing control strips is for the user to decide based on your workload and work patterns. You may only need to do it daily or you may want to do it at the beginning, middle and end of each working session. We suggest that at least one control strip is processed per working session and it is best to do this and assess it before any other film is processed. However, in a busy working environment this may not always be practical. After processing the strip, measure the density of the patches using a calibrated transmission densitometer and record the results for Dmin, LD and HD-LD on the process control chart you have started. Remember a visual assessment of density cannot be relied upon for process control to operate.

The steps involved in the day-to-day monitoring of your process using the ILFORD process control system are:

Prepare the processor for work.

- 1 Check the processor's functions are working and set correctly, e.g. solution temperatures, agitation systems, speed controls, replenishment solutions and rates, etc.
- 2 Process a control strip.
- 3 Visually assess this control strip.
- 4 Measure the control strip densities.
- 5 Calculate the HD - LD value
- 6 Plot the control strips LD and HD - LD values on the control chart you have started.

Instructions for preparing your processor for work should be covered by the manual for the particular machine you are using. You may need to top up the process tanks with water to compensate for any overnight evaporation from the solutions. Allow the processor to get up to its working temperature.

When the processor is ready for work, process a control strip, using the same settings and temperature as for the master strips. Examine this strip visually for streaks, spots, drying marks etc. then measure the density of the Dmin, LD and HD patches, and calculate the HD-LD value. Enter the Dmin value in the Dmin box in the next free column of the control chart. Then, for the LD and HD-LD figures, subtract the aim values from each of the newly measured values to obtain the plot values from the aim as shown below.

Example

	LD	HD-LD
New strip	0.49	0.79
Aim values	0.48	0.80
Plot values	+0.01	-0.01

Plot the results on the control chart in the same column as the Dmin value, adding the date, time and any comments at the top. The process is considered in control provided that the measurements from subsequent strips are within ±0.06 units of the established aim values, i.e. the plot stays within the boundaries of the upper and lower "ACTION" lines marked on the PROCESS CONTROL CHART.

Regularly recording other pieces of information on the chart is also very useful as it can help to diagnose any problems that occur e.g. keeping a tally of the films processed during the day and adding the total to the chart is a very useful piece of information as is adding the results of any pH and specific gravity measurements and any changes in solution temperature you have made.

Making new master strips and adjusting aim values

New master strips are needed when the chemicals are replaced and when a major adjustment has been made to the developer. For example, if part of the developer tank solution has been drained and refreshed with new developer solution or if the working temperature is changed significantly. It is advisable to start a new PROCESS CONTROL CHART when you make new master strips.

Before making new master strips, the processor must be producing good results, but do not make new master strips immediately after a period of inactivity, for example, a weekend. To prepare new master strips repeat the procedure given the section above called "Preparing master strips and aim values".

New master strips and aim values can be made when changing to a new box of FP4 Plus CONTROL STRIPS as there might be slight variations between boxes of strips due, for example, to different ages or storage conditions or slight changes in exposure. However, it is more convenient to just adjust the existing aim values for the performance of the new strips. To do this process the last strip in the old pack at the same time as the first strip of the new pack. If the old and the new strips give the same readings continue as normal.

If the two strips give different readings, adjust the aim values for LD and HD-LD, and start a new process control chart. Adjust the aim values by subtracting the value on the old strip from the value on the new strip and adding the result to the aim value.

Example

Assume the LD aim value is 0.48. If the LD value of the last strip in the pack is 0.50 and the LD value of the first strip of the new pack is 0.49, then add -0.01 to the LD aim value, making it 0.47.

DEALING WITH PROCESS VARIATIONS **Identifying process variations**

A properly replenished and maintained developer in regular use should have a long tank life. Any large process variations seen are most likely to be caused by an external change. If a sudden and significant process variation has occurred it is most important to identify the cause so that the appropriate corrective action can be taken.

For the life of the developer both the LD and HD-LD plots should remain between the two "ACTION" limit lines that are marked on the PROCESS CONTROL CHART. Movement between these lines should be minimal but if they do occur they should be gradual undulating trends rather than sharp swings from one extreme to another.

However, random variations are bound to occur occasionally, so when you plot a point that lies outside the limits, immediately process and plot another strip to check the first result. If the plotted points from the second strip are inside the action limits continue to use the developer as normal. If the results from the second strip are outside the same limit, action is needed.

It should still be possible for you to continue processing so long as the results remain inside the "CONTROL" limit line that is marked on the PROCESS CONTROL CHART. However, it is advisable to process a test film to assess the acceptability of the negatives produced before continuing.

If a point is plotted outside one of the "CONTROL" limits, and the results from a second strip are also outside the same limit, you should not process any further films until the source of the variation has been corrected.

Identifying a problem

The most important part of dealing with process variation is identifying what has caused it. Replenished developer systems, should have a very long tank life as the developer in the tank is being replaced as it used, so any process variation is most likely to be caused by an external change. If you do not find the cause of a problem you cannot prevent it from recurring.

Firstly, look for the obvious. The cause of the process change may be something visible, such as low solution level or blocked pipes. Put a test film through the machine and check that it correctly triggers any agitation, replenishment etc. Also check for any obvious source of contamination, e.g. something floating in the developer, cloudiness or an unusual odour.

Next check all of the machine settings. Somebody may have changed the temperature, development time or replenishment rate for a particular job, or merely by accident. If possible, verify the settings by measuring what has actually been set using thermometers, measuring cylinders etc.

Regaining control of the process

Once the cause of the problem has been found and corrected then some action will probably be needed to get the process back within limits. It might happen automatically, for example if the temperature has been returned to the correct setting. If the problem was caused by low replenishment then removing a few litres of developer and replacing it with an equal amount of fresh developer or replenisher solution may bring the process back in control. In the extreme case to get back inside the limits may need all of the developer solution replacing with fresh developer.

If the reason for poor performance is contamination of the developer by stop bath or fixer then remove all the developer, flush out pumps and pipes, clean the tank and change the solution filter before replacing with a fresh solution.

A guide to the severity of the problem can be gained by studying the shape of the plot on the PROCESS CONTROL CHART. There are basically two types of change, gradual and sudden. A gradual change shows as a trend in one or more of the control plots stretching over days or possibly weeks. This normally indicates a small change in processing conditions, which is more likely to be cured by replacing a relatively small amount of developer or a small adjustment to replenishment rates.

A plot that shows a sudden change from a stable situation to out of control in one jump is likely to be caused by a major contamination. This is likely to require a complete change of developer, and possibly flushing of the machine as well, to remove the problem.

You should note that neither of these categories is absolutely exclusive. If in doubt, err on the side of safety and replace the developer.

For more information about what the PROCESS CONTROL CHART plots are telling you and dealing with common causes of process variation read the ILFORD FPC PROCESS CONTROL FAULT FINDER GUIDE.

A wide range of fact sheets is available which describe and give guidance on using ILFORD products. Some products in this fact sheet might not be available in your country.