

# DARKROOM AUTOMATION

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## PYRO

### PRECISION ENLARGING METER SUPPLEMENT

This document is a supplement to the Precision Enlarging Meter Instruction Manual. When making prints the PYRO model is used in much the same manner as the regular meter. If you are new to Darkroom Automation meters you should first familiarize yourself with the meter's operation with normal silver-image negatives and then come back to this supplement.

The Pyro meter has a mode to correct meter readings to compensate for the stain produced by pyrogallol, catechol and other staining developers. In pyro mode the only difference in operation is that the meter needs to take a baseline measurement of the base+fog from a clear margin of the negative. Once this measurement is made the meter readings will follow the paper's response to the stain.

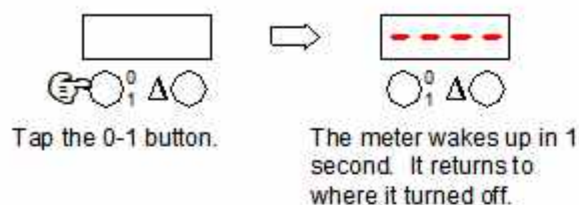
Before using the meter you will need to find the stain factors. Because of the large number of variables affecting the level of stain it is not possible to provide factor information with the meter.

To use the meter you must have a very consistent processing flow. You need to use a stable developer such as PMK or PCAT. Older formulas, like ABC pyro, are too variable in their staining action to make metering viable.

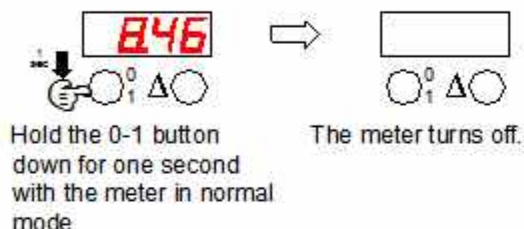
The following two pages diagram the operations and displays of the pyro model. Refer to them in the instructions that follow. You will notice that in some minor aspects the pyro model displays are slightly different from those of the regular meter.

The meter's display is shown in red in an OCR font: **P7.6°3**. The numbers are an example - in use the meter will show the measurements for your negative.

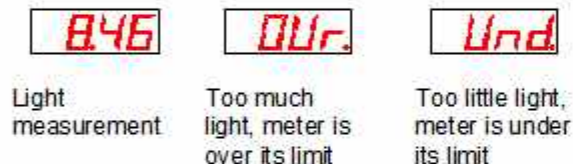
## Turn the meter on



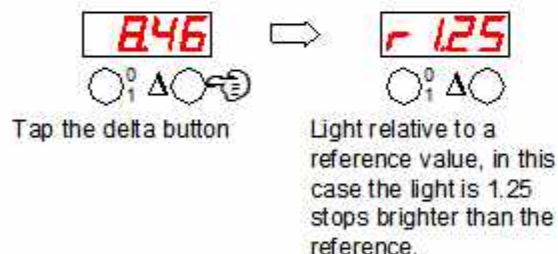
## Turn the meter off



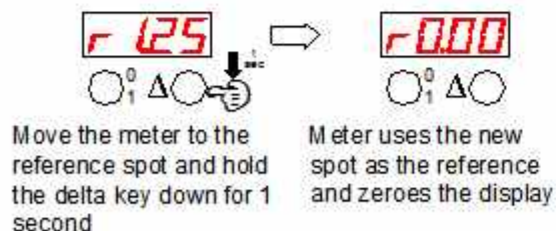
Normal Mode: measure the amount of light in stops for normal negatives



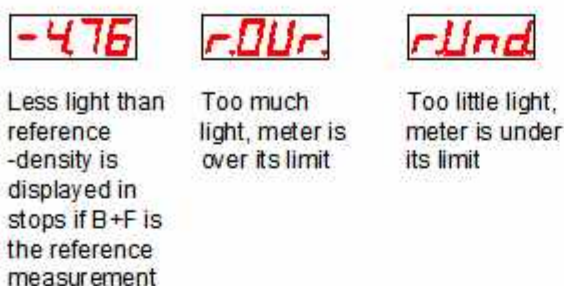
## Measure relative to a reference reading



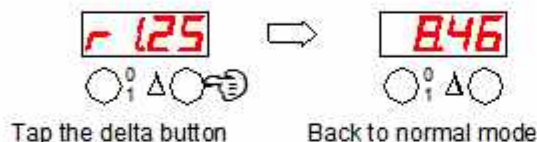
## Take a new reference reading



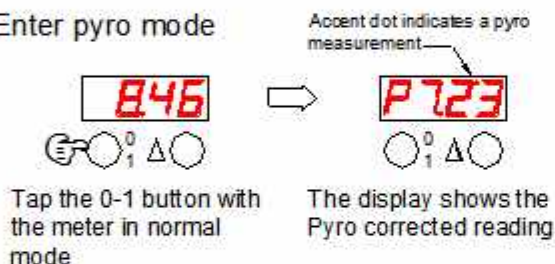
## Relative measurements



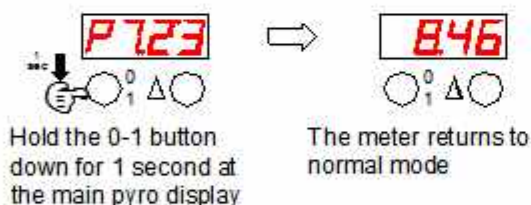
## Stop relative measurements



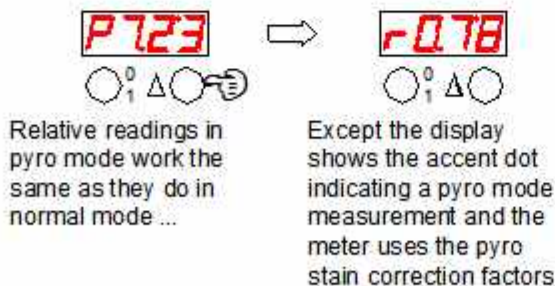
## Enter pyro mode



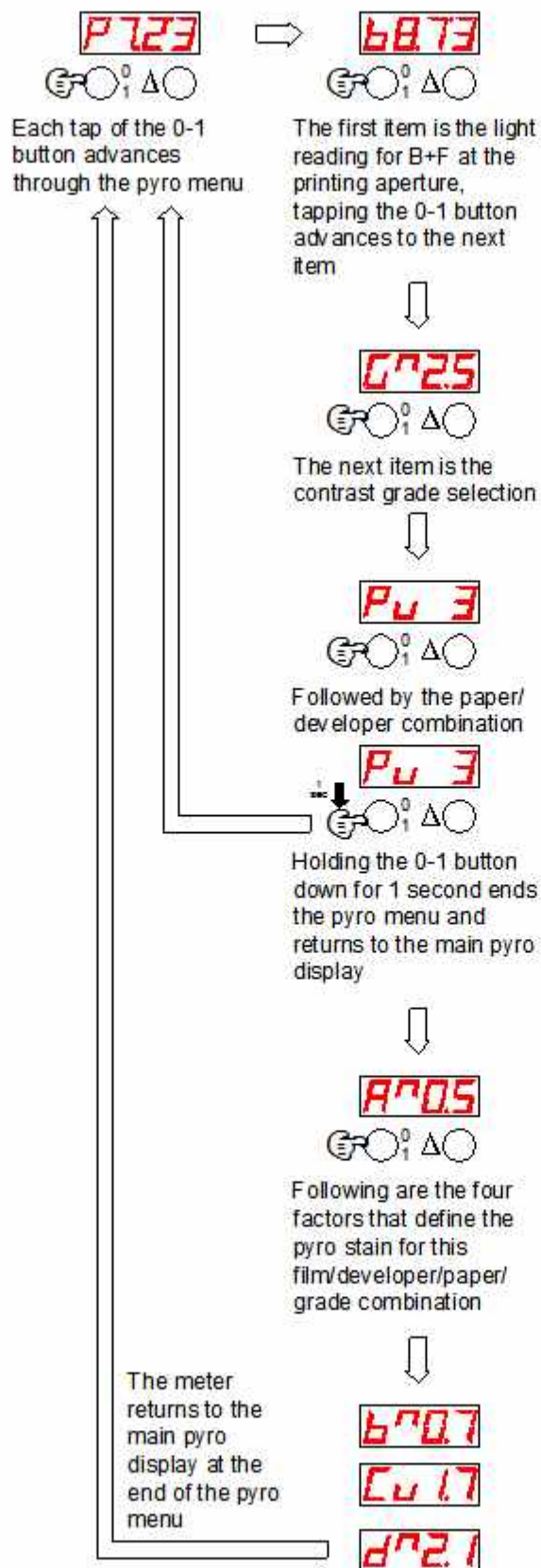
## Exit pyro mode



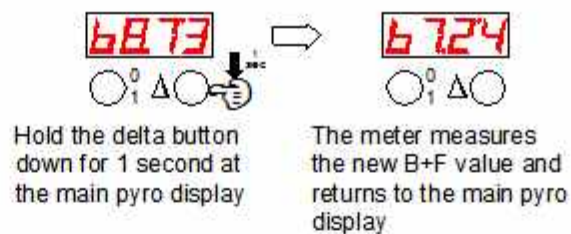
## Relative readings in pyro mode



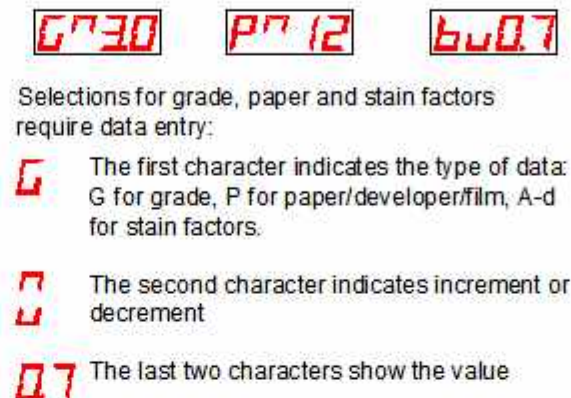
## The pyro menu



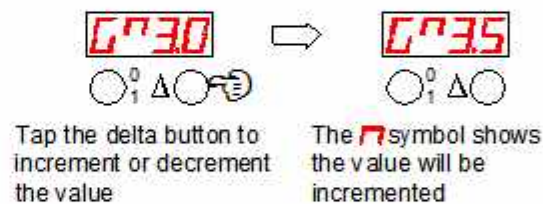
## Take a new B+F reading for a pyro negative



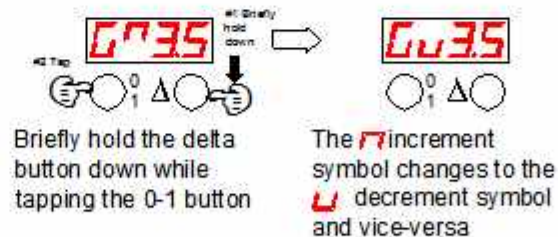
## Enter data



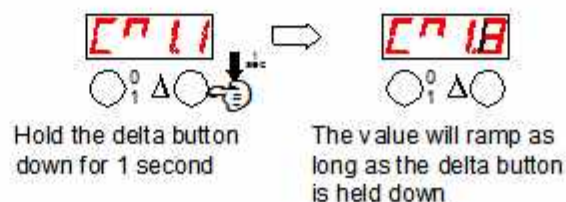
## Change the value



## Switch between increment and decrement



## Ramp a value



# OPERATION

## Regular Mode Operation

In regular mode the meter functions like the standard meter. Refer to the meter manual for instructions.

In pyro mode the meter again functions like the standard meter, except that pyro stain factors are applied to the reading. The operation of the meter when making a print in pyro mode is the same as in regular mode.

## Entering and Exiting Pyro Mode

Turn the meter on by pressing the 0-1 button. The meter will turn on in normal mode. If the meter turned itself off because of inactivity then the meter will turn back on in the same mode it was in when it powered down.

Tap the 0-1 button and the meter will enter pyro mode and the display will change to show a leading 'P' along with an accent mark above the reading: **P7.6°3**. The accent mark is present in all pyro readings.

To exit pyro mode hold the 0-1 button down for one second; the meter will exit pyro mode and the display will change back to the normal display: **8.62**.

## Taking a Base+Fog measurement

You must take a B+F measurement before making pyro measurements. The enlarger should be set to the same height and aperture as you will use for making prints. All filters need to be removed from the light path.

After entering pyro mode, tap the 0-1 button to show the current B+F reading. The display will change from **P7.6°3** to **88.0°0**.

To take a new B+F measurement place the measuring spot under clear film. If your enlarger's illumination isn't all that even then it may be a good idea to move the negative so that the clear negative is in the center of the field. Press the  $\Delta$  button and hold it down to take the new measurement, the meter will show the base + fog illumination: **88.6°2**. Hold the button down until the reading is steady and then release it. The meter will return to pyro mode and display the corrected pyro reading **P8.6°2** (which should equal the B+F reading as there is no image density).

The B+F measurement is remembered when the meter is off. It is reset to 8.00 when the batteries are changed.



## Selecting the Paper and Contrast Grade

Each combination of film, developer, paper and contrast grade will have it's own stain factors. Each combination of film, developer and paper is filed in the meter as a 'paper'. The meter holds stain factors for 10 VC papers with 12 grades each and 20 graded papers. Naturally, you must tell the meter what paper and grade you are using. The paper and grade settings are remembered when the meter is off but, like the B+F reading, are reset when the batteries are changed.

To display and change the current contrast grade, **Gu2.0**, hit the 0-1 button twice when in pyro mode. Grades go from 00, 0, 0.5 ... to 5.0. Instructions for selecting the grade are provided in the illustrations on page 3, under 'Enter Data'. Papers 1 - 10 are meant for storing factors for VC paper and have grades. Papers 11 - 30 are meant for graded paper and the grade display is not present.

If you are only changing the grade then you can return to the pyro display by holding the 0-1 button down for one second.

To display and change the film/film developer/paper selection, **Pu 2**, hit the 0-1 button one more time. Change the paper selection in the same manner as the grade. If you have only changed the paper then the meter will recall the last grade you used for the new paper and display it. The meter remembers the current grade for each VC paper.

To return to the main pyro display after selecting a paper and grade you can hold down the 0-1 button for one second.

To advance to changing the stain factors for the selected paper and grade (reference pages 2 & 3) hit the 0-1 button. You would only do this when recalibrating.

## Determining the Optimum Paper Contrast

Finding the optimum contrast for making a print proceeds in the same manner as shown in the main meter manual. However, some caveats apply:

The stain factors change with changes in contrast filtration - stain factors are negligible with low contrast filtration and can be quite large with high contrast filtration.

Because of this, determining paper contrast can be a bit of an iterative affair:

1. Guess at the right contrast grade and set the meter to this paper and grade;
2. Meter the negative and see if the grade is correct;
3. If not, guess at a new grade and set the meter appropriately;
4. Check the second guess, usually it will be correct, but if not then another trial may be needed.

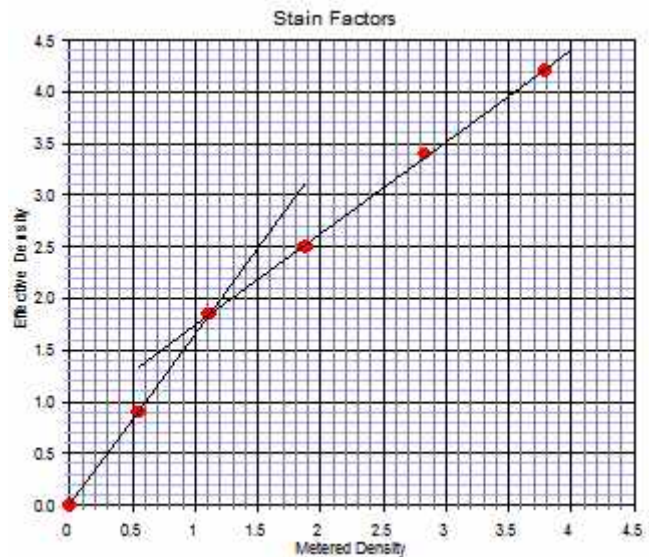
## Entering Stain Factors

Each paper (really a film, film developer and paper combination) and grade has a set of stain factors associated with it.

The stain factors relate the density that the meter reads with the density the paper sees. If the relationship is plotted it looks something like the graph at right.

Different combinations of materials produce different relationships between the metered and the effective density.

The meter is able to take two sets of values that define the relationship. For the graph shown at right, the values would be



<u>Metered</u>	<u>Effective</u>
1.1	1.8 Stops
3.8	4.2

These are entered into the meter as A-B for the first pair of numbers and as C-D for the second.

The procedure for entering the stain factors is the same as the one for entering the paper and grade.

The stain factors are stored in the meter's non-volatile memory and are remembered with the power off or the batteries removed.

The next section of this manual details characterizing the film, the paper and the interaction between the two so that the stain factors can be determined.

# STAIN FACTOR DETERMINATION

If you have information from Zone system testing or BTZS testing you may already have some of the information that is needed for factor determination. If so, you may skip some of the steps and use your existing data.

The procedures may seem involved at first, but the worksheets have been designed to make the process as easy and 'brainless' as possible.

After the testing is complete you will have, along with the stain factors, a complete Zone System test of your film and paper.

## Accuracy requirements:

Determining stain factors can mean matching tones and exposures to 0.1 stop or better. Because of this requirement:

- The paper and stain factor tests must be made with paper from the same box. The stain factors, though, will apply to all boxes of the same paper;
- The paper and stain tests must be made on the same equipment.

If you use a test strip method it is best to use discrete individual exposures for the test strips and to move the paper between exposures so that all exposures are made at the same location. The Darkroom Automation Memory f-Stop timer can be switched between discrete and progressive test strip modes to aid in this process.

However, if your enlarger illumination is even to better than 0.1 stop, or if you are willing to compensate for uneven illumination by adjusting the meter readings, you can use progressive test strips without much problem.

To make a table of corrections for compensating for uneven illumination:

1. Mark the location of the steps as they are projected on the easel or the location where the test patches will be exposed;
2. Insert a blank film in the enlarger and zero the meter's delta mode at the location of step one;
3. Take measurements at each of the step locations, noting the delta's as you move the meter from step location to step location;
4. Apply the delta corrections to all meter readings made at those step/patch locations.

The correction data will only need to be collected once if you keep the enlarger and lens constant for all your testing.

The following pages show example worksheets. The data in the sheets is from a real test of Plus-X 35mm developed in PMK and printed on Ilford MGIV RC.

# Film Test

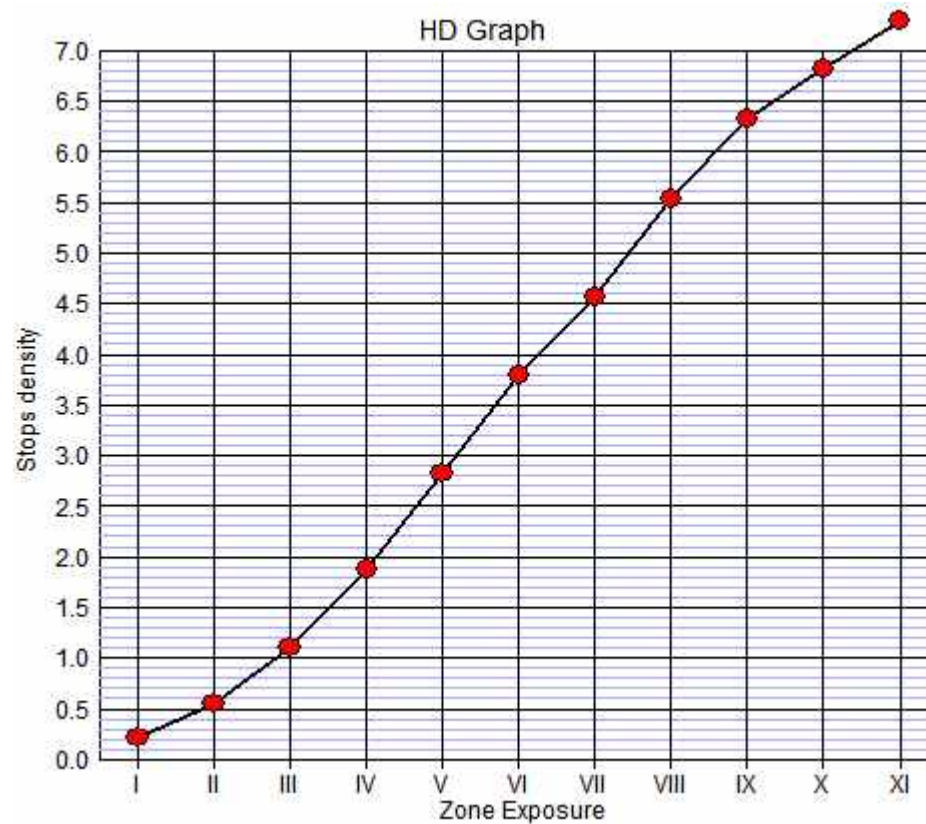
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Sheet F-	14	Date	10 Dec 2009
Film	Plus-X 135	Roll Id	PX/PMK/14
Developer	PMK	Notes	
Time/Temp	14/70		
Agitation	5/30		
Method	sm. tank		

Camera	Nikon FM2
Lens	Micro-Nik 50
Meter	Int
Shutter	--
Method	Slide duplicator

Enlarger	Beseler 45	Elevation	15"
Lamp	Condenser	f-Stop	4
Lens	50mm Nik	Meter-air	9.58

Frame	Zone	Shutter	f-Stop	Metered Density	
Undeveloped	B	---	---	.69	/air
	B + F	---	---	1.66	/air
12	0	1000	5.6	.07	
11	I	500		.21	
10	II	250		.55	
9	III	125		1.11	
8	IV	60		1.88	
7	V - metered	30		2.83	
6	VI	15		3.79	
5	VII	8		4.57	
4	VIII	4		5.53	
3	IX	2		6.32	
2	X	1		6.82	
1	XI	2'	5.6	7.30	





# F-: THE FILM AND DEVELOPER TEST

As mentioned in the introduction, in order to use a meter on pyro negatives you need to have a very consistent work flow and use materials that produce consistent results. Pyro developers are notorious for the variability of their stain and historically have never been amenable to characterization. However, some modern formulas - PMK and PyroCat in particular - are quite consistent and are compatible with sensitometric methods.

If you have a set of Zone exposure negatives for your film and developer then you can skip down to the 'measure the densities' step. You can't use your present density data because you need to find the densities the meter 'sees'.

A worked example worksheet for this test is on the page at left. Blank 'Xerox Masters' are provided on card stock. PDF files for the worksheets are available on the [darkroomautomation.com](http://darkroomautomation.com) web site support page.

## Steps:

1. Give the sheet an 'F' number so that you can reference the sheet. Put this same F number on the negative(s) so you can match negatives to the sheet to minimize mix-ups.
2. Generate a set of test negatives

The test negatives are made at one stop intervals about a metered Zone V exposure. The negative can be made by contacting a step wedge or by exposing film in a camera.

We are not concerned with the exact amount of exposure given - all we are looking for is a set of reasonably stepped densities and corresponding stains.

- Roll film: The worksheet shows a test made by exposing 35mm film in a camera. In the test above, a slide duplicator, without a slide, was used as a test target because it gives very uniform illumination across the frame. Other subjects can be a clear sky or a uniformly lit wall or test card. The frame, shutter and f-stop data can help in planning the shots and can help reduce the chance of error.
- Step Tablet: If you are contacting a step tablet then the step number would go in the 'frame' column. Because density is always read in the enlarger the small step size of a contacted tablet is not an issue. A hybrid method is to take a photograph of a step tablet, say using a step tablet in a slide duplicator - however experience has shown that a strip of test frames is more convenient to work with.
- Sheet Film: The obvious method is to expose 12 sheets of film. This can be expensive and so many sheets can be hard to manage. An alternative is to

make 4 or 6 exposures on a sheet of film by inserting the dark slide as multiple exposures are made, much as one would make a test print. If the shutter is used the sequence of shutter speeds would be (as an example):

- make an exposure at with the slide out 1/500;
- insert the slide 1" and make another 1/500 exposure;
- insert the slide another 1" and make a 1/250 exposure;
- insert the slide another 1" and make a 1/125 exposure ...

The result is a sheet of film with 1/500, 1/250, 1/125, 1/60.... exposures.

When 1 second is reached it is probably preferable to open the aperture one stop with each exposure. Remember the first shutter speed is used twice and then the time is increased one stop with each insertion. Mark the darkslide with penciled lines to aid in inserting it an inch (or fraction thereof) at a time.

3. Develop the film, noting the time, temperature, agitation, method (small tank, Jobo, tray ...) and any other factor that may be relevant to achieving consistent results. Develop a blank sheet, or leave a blank exposure for B+F determination. For base density determination add a bit of undeveloped film along with the test film when it hits the fix.
4. Measure the densities using the meter (in regular mode) and your enlarger. Set the enlarger height and aperture so that the meter reads around 9 to 9.8 with no negative in the enlarger. Press and hold the  $\Delta$  button to take a reference reading - the meter will show **r0.00**. Now insert the film base and B+F negatives and note the densities of each. Zero the meter with the  $\Delta$  button on the B+F negative and measure the remaining negatives (or steps, if using a contacted step tablet), noting their densities on the work sheet.
5. Plot the results (optional) on the provided graph. It can be nice to see the results of the exposure test and it can give you a warning if some reading or exposure is in error. You can put a straight line through the straightest part of the HD curve for a quick and dirty determination of gamma/CI. Note that this gamma is the gamma of your negative in your enlarger - a much more useful number than one determined on a densitometer and then fudged for your enlarger type. After the stain factors have been determined you may want to come back and see the stain's contribution to gamma. With VC paper the contrast filter will interact with film stain to give different effective gammas for each contrast grade.

The data gathered here will be used for all tests of this film/developer with different papers and contrast filtrations/grades.

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# Paper Test

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Sheet # <b>P-</b>	13	Date	10 Dec 2009
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Paper	MGIV RC	Contrast	3
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Test Strip Conditions			
Enlarger	Beseler 45	Elevation	15"
Head	Condenser	f-Stop	16
Filtration	#3 UL	Lens	50mm Nik
Developer	D-72	Dev.	Tray
Time/Temp	2/70	Meter	5.50

## Find Black Point Test Strip

Expected black exposure					9.5		
Meter reading					5.50		
Expected time					4.0		
Start	3.8	Step	0.1	Black	3.8	Exp.	9.3

## Find White Point Test Strip

Expected white exposure					5.4		
Meter Reading					5.50		
Expected time					-0.1		
Start	-0.3	Step	0.1	White	0.2	Exp.	5.7

Black exposure - White exposure				3.6
Divide by 30				0.12
Round to the nearest 1/10th of a stop				0.10

A	Time	Exp.	OD
1	0.2		
2	0.3		
3	0.4		
4	0.5		
5	0.6	6.10	
6	0.7		
7	0.8		
8	0.9		
9	1.0		
10			
11			
12			

B	Time	Exp.	OD
1	1.1		
2	1.2		
3	1.3		
4	1.4	6.90	
5	1.5		
6	1.6		
7	1.7		
8	1.8		
9	1.9		
10			
11			
12			

C	Time	Exp.	OD
18% 1	2.0	7.50	0.736
2	XXX		
3	2.3	7.80	
4	2.4		
5	2.5		
6	2.6		
7	2.7		
8	2.8		
9	2.9		
10			
11			
12			

D	Time	Exp.	OD
1	3.0	8.50	
2	3.1		
3	3.2		
4	XXX		
5	3.5		
6	3.6		
7	3.7		
8	3.8		
9	3.9	9.40	
10			
11			
12			

E	Time	Exp.	OD
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

F	Time	Exp.	OD
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			

## P-: THE PAPER TEST

After generating a set of negatives that express the staining action of the developer we need to characterize the paper that is going to be used with the negatives. Again, a sample worksheet is provided on the facing page.

The paper test only needs to be run once for each paper and grade, the same data here will be used with all the film/developer combinations you may use.

This test will generate a set of 30 or equally spaced tones from black to white. A large number of tones is generated to enable accurate matching without the use of a densitometer.

If you have a densitometer and are able and willing to interpolate the exposure/tone relationship you need only make a 10-or-so step test strip or you can project and meter a 31-step tablet to generate a set of tones. And if you already have a zone strip for the paper, along with a densitometer and calculator, you can skip this entire test and just fill in the exposure and density information in the 'A' test result block.

1. Give the sheet a P- number, mark this same P number on the back of any test prints - as you expose them in the enlarger - to minimize confusion later. You will need to refer to the strips often, so keep them safe - an envelop taped to the back of the P- worksheet is a good location.
2. Find the required exposure for almost max-black and almost paper-white. The Darkroom Automation web site has paper speed information for several papers and developers, and the meter shipped with paper speed information for common Ilford papers. You can use this information, or exposure information you may already have to determine the black-point and white-point exposures.

The black and white points don't have to be exact, and if you like you can just use the information in the paper speed charts without any further testing. A step size of 0.2 works for grades 0 through 2.5 and a step size of 0.1 works for grades 3.0 through 5.0.

If you are using a paper for which you don't have much information and need to make test strips to determine the white and black exposures there are boxes in the lower left of the worksheet that can be used for this purpose:

- Set the enlarger so the meter reads about 5 stops of light on the easel - this will give a roughly 1 second exposure on MGIV for the white point.
- Start with a guess for the exposure, using the paper speed charts for the black and white paper speeds and/or some guess work. Subtract the meter reading from the paper speed/guessed exposure to find the approximate time, back off a bit and make a test strip that spans the expected exposure. Develop and note the time and exposure for the black or white point. When finding the black point you may want to speed things up by opening the



enlarger lens so the meter indicates about 8 stops of light.

- As always, meter without any filtration and then apply the filtration when exposing the paper.
  - The lower left box in the worksheet will help you find the step size and the number of test tones you will need.
3. Make a series test prints. 5x7 cut into 4 long strips will give 9 or so tones/strip, 8x10 paper cut into 5 long strips will give 12 tones/strip. Mark the back of the test prints with the P- number you have given to the sheet followed by A-F.

Develop and dry as usual. Do not tone the prints.

If you have a Zone system step tablet or densitometer you may want to mark the Zones in the OD column. You will need to find the 18% tone, it can be found by comparing the test strip patches to an 18% grey card.

4. If you are projecting a 31-step tablet you should expose the projected tablet so you get a solid black on step 2 or 3 (remember that you will need a densitometer and interpolation). Meter each patch, add the exposure time (possibly subtracting any compensation that may be needed to make up for uneven enlarger illumination), and put the resulting exposure in the 'Exp' column of test strip data. If you like, measure the OD of the resulting tones and put them in the OD column.

While the prints are drying move on to the stain factor test.

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# Stain Factor Test

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Sheet #	S-16	Date	10 December
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## Combination

Film	Plus-X 135	Paper	MGIV RC
Film Developer	PMK	Contrast	3
Film test sheet#	F - 14	Paper test sheet#	P - 15

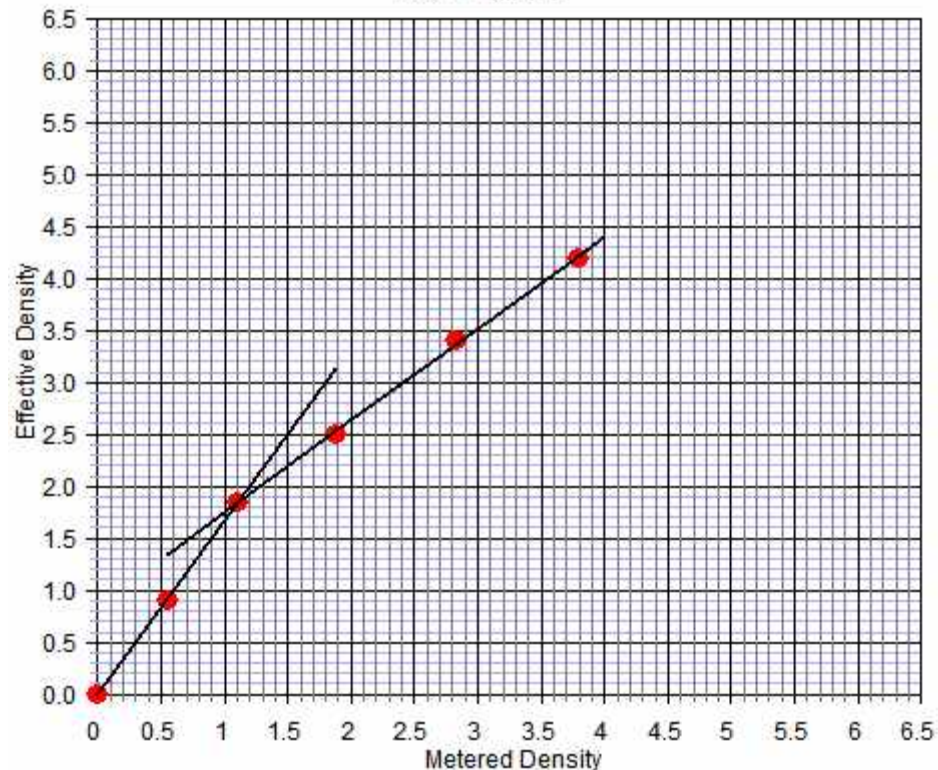
## Test Strip conditions

Enlarger	Beseler	Elevation	15"
Head		f-Stop	16
Filtration	#3 Ilford	Lens	50mm Nik
Developer	D-	Dev. method	Tray
Time/Temp	2/70		
18% Grey exposure (GX) from P- 13C1 7.5			
Meter Reading Zone V frame (MR ZV) 2.67			
Zone V Time (XT ZV) = GX - MR ZV 4.8			

## Stain Factors

P	3
G	3
A	1.1
B	1.8
C	3.8
D	4.2

## Stain Factors



		B+F	0	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Film Test F - 14	Frame				10	9	8	7	6	5				
	Metered Density (MD)				.55	1.11	1.88	2.83	3.79	4.57				
This test strip	Meter reading (MR)	5.50			4.95	4.39	3.62	2.67	1.71					
	Exposure Time (XT)				4.8	4.8	4.8	4.8	4.8					
	Zone Exposure (ZX) = (MR) + (XT)				9.75	9.19	8.42	7.47	6.51					
	Strip reflectance density (OD)													
Paper Test P - 15	Matching Patch				D9	C9+	C3	B4	A5					
	Patch Exposure (PX)				9.4	8.45	7.8	6.9	6.1					
Calculation	Exposure Difference (XD) = ZX - PX				.35	.74	.62	.57	.41					
	Effective Density (ED) = XD + MD				.90	1.85	2.50	3.40	4.20					

## S-: THE STAIN FACTOR TEST - FINDING THE INTERACTION OF FILM AND PAPER

This final test generates a test-strip print of the zone negatives developed in step 1 and correlates the resulting print tones with the tones generated in the paper test.

A filled-in worksheet is shown above. On your worksheet start by assigning an S-number. Note the F- and P- numbers of the worksheets for the film and paper you will be bringing together in this test.

The paper test P- must have been made with the same light source, paper lot (ideally paper from the same box) and contrast filtration you will be using in the stain factor test.

From the film test sheet F- copy the metered densities into the MD row of the bottom box.

Insert the negative(s) in the enlarger and meter each negative. Place the reading in the MR row of the bottom box - note that even though this is a pyro negative the meter is being used in normal mode at this time. Alternatively, you can just meter the B+F negative and calculate the MR's from the densities in the MD row and the B+F density:  $MR = B+F - MD$ . If you are using a step tablet image then read off the density of the steps that correspond to the Zone system intervals either side of ZV.

From the paper test find the exposure that generated an 18% grey tone and note it in the center left box as GX (7.5 in the example worksheet). Meter the ZV negative and adjust the aperture so the meter reads around 3 stops less than GX (note that this wasn't done in the above worksheet). Put the actual meter reading in the MR ZV box (2.67). Subtract the two values <GX - MR ZV> to find the Zone V test strip exposure time XT ZV (4.8). If there were no effect from the pyro stain the ZV negative will generate an 18% tone on the test print with this exposure. Because of the stain the resulting tone will be lighter than 18%.

Put the XT ZV time in the exposure time row XT (4.8) for column ZV in the bottom box and tones to either side. If the test is to incorporate a wide range of densities it may be desirable to lower the exposure time for Z0 through ZIII (as an example, reduce it by 1-2 stops) so they print in the mid-greys and not in the deep blacks on the paper's shoulder; and raise the exposure time for ZVII through ZIX (by 1-2 stops) and again for ZX and ZXI (by 2-4 stops) so these negatives don't print pure white. The amount to adjust the exposure is determined by the range of paper exposures found in the P- sheet test strip results. For the first few tests you work through don't bother with these niceties.

In each zone column add the exposure time (XT) and the meter reading (MR) and place the result in the zone exposure (ZX) row.

Expose a test strip of one patch of each negative using the time given in the XT row.

Process and dry the strip.

Take this strip and go back to the grey-scale test strips generated in the paper test. For each tone on the test strip find an equal tone in the paper test strips - note the number in the 'matching patch' row. An eyeball match under bright light is normally accurate enough. If you have a densitometer and wish to use it then measure the densities of the test strip and put them in the 'strip reflectance density (OD)' row; match these numbers with the OD numbers in the paper test and write down the matching patch.

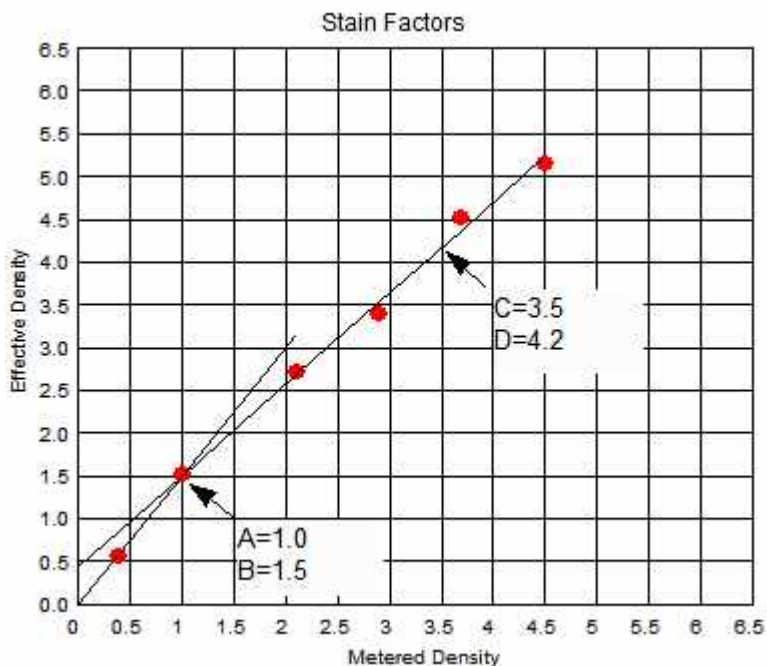
Write down the exposure for the matching paper test patches (from the P- sheet) in the patch exposure PX row.

Write down the exposure difference between the test strip zone exposure and the patch exposure, ZX - PX, in the XD row.

Obviously, the two exposures - PX and ZX - when seen from the paper's viewpoint are identical. The difference in row XD isn't really a difference in the exposure but a difference in the metered exposure. If this difference were added to the meter readings for the pyro test strip the meter reading of a pyro negative would equal the meter reading for a regular negative.

We now find the effective density of the pyro negative for each of the zones by adding the metered density of the negative from the MD row (data from the film test F-) and the exposure difference XD.

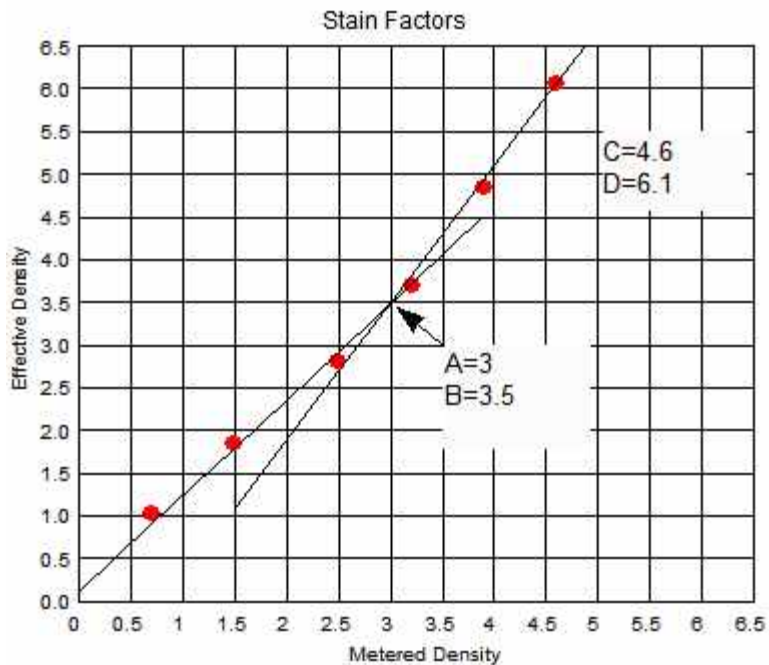
Plot the results in the provided graph. Several possible results may ensue, depending on the combination of film, pyro developer, paper and contrast grade. In general the plots will look like one of the following:



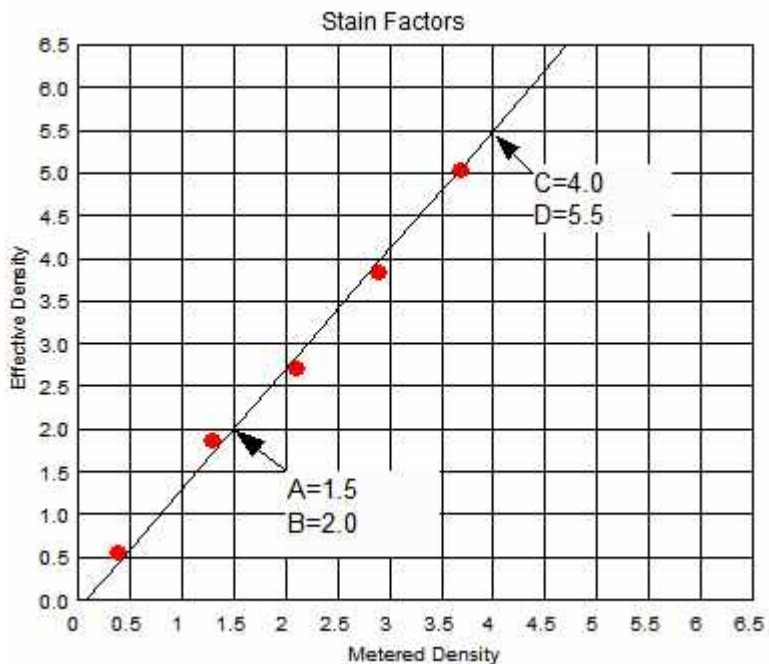
The red dots are the points from the MD and ED rows in the worksheet.

Place one or two lines that best represent the line-up of the dots. The first line must go through the point (0,0) or very close to it. The positioning of the lines is, obviously, a judgement call - however, a good eye-ball estimation is more than sufficiently accurate.





If you have two lines, then the first set of stain factor coordinates A and B is at the intersection of the two lines, as shown in the plots at left and above. The second set of coordinates C and D is at some convenient point to the right.



If there is just one line then pick representative locations along the line. The points shown were picked just because they went through convenient intersections on the graph. The two points you pick aren't material as long as they both lay on the line.

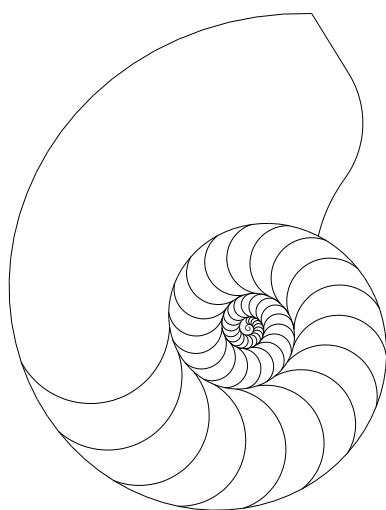
Note the points on the worksheet for the paper and grade numbers and enter the factors into the meter.

P 3	Paper	MGIV RC
Film PX-135	Developer	PMK

	S -	A	B	C	D
G 00					
G 0					
G 0.5					
G 1.0					
G 1.5					
G 2.0					
G 2.5					
G 3.0	S-16	1.1	1.8	3.8	4.2
G 3.5					
G 4.0					
G 4.5					
G 5.0					

A sheet is provided for keeping a paper record of all the paper factor information in the meter. The information for this test would be entered as shown.

These factors will be applied in pyro mode every time this paper (in the example P3) and grade (3) are selected.



## DARKROOM AUTOMATION

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