Kodak

Micrographic Quality
D-17

Control Procedures for Source Document Microfilm Processing

BUSINESS
IMAGING
SYSTEMS

with
Image Optimization Procedures for Diazo, Vesicular and Silver Microfilm Duplication

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Introduction

What is process control?

Process control is defined as the method of predictability for captured images before they are developed and repeatable results are obtained. Process control procedures are based on utilizing known exposures, film and analytical tools that are independent of production microfilmers so daily adjustments can be made to the processor. These known exposures and film are known as control strips. Control strips are the foundation of process control procedures. This publication is devoted to the outline of control procedures and the use of control strips for source document micrographic production. Also, an explanation of micrographic and processing fundamentals, control procedures and image optimization procedures for diazo, vesicular and silver duplicating microfilm is provided.

Computer Output Micrographics (COM) typically does not utilize process control strips. Historically process control was utilized with COM when "full reversal" processing was used to produce a negative image from the negative CRT image in most COM recorders. Today, virtually all COM recorders utilize a direct image COM film that will produce the desired negative image by virtue of the film. Image quality in this application is highly dependent on the COM device and the film being used. *This publication will not cover the COM application.* If process control procedures are deemed necessary, consult your local Kodak Representative.

Why use process control?

Practicing process control procedures is the most important and critical element of the entire micrographic process. In a processing environment where there are many variables that can affect the quality of images, it is very important to have a method of monitoring these variables. If this is not done, much time and money can be lost either re-microfilming or troubleshooting processor operations.

From the initial capture of a document to the delivery of high quality micrographic images and duplicates, the ability to consistently achieve the same results hinges on understanding and employing process control procedures. "It is simple, it works and it saves a lot of time."

The most basic and fundamental principal in micrographics is that; *"All microfilm cameras and duplicator exposure devices should be adjusted to the processor. The processor should never be adjusted or compensated to cameras. The processor is the foundation of the entire micrographic process."* Having a processor that either varies or is adjusted to compensate for exposure anomalies is the most common cause of inconsistent and low quality images.

Typically, process control procedures are most important and used under the following situations:

- when a deep tank processor (tanks >5 gallons) is used
- chemicals are being mixed from a concentrate into a working solution
- microfilmed images are processed at a remote location or from many different cameras
- in a high production environment where many cameras are feeding one processor

Note: If a tabletop processor is being used with pre-mixed chemicals, such as the *Kodak Prostar* Processor, not all of the procedures outlined in this publication are applicable. The *Kodak Prostar* with *Kodak Prostar* Plus Chemicals is a system that is highly dependable with very low variability. In this case, there is only one variable (temperature) which will affect the densities of captured images. However, if chemicals are being mixed from a concentrate to be used in these type processors, further care must be taken to monitor the processor's output.

For a basic understanding of image capture, development and the elements which comprise and affect processing and process control, refer to the "Micrographic fundamentals" section of this publication.

Source document process control

Elements of process control

Control strips

Image development is the most critical stage of a photographic process. In order to produce high quality images consistently, process control strips are used to monitor the "activity" of a processor. "Activity" refers to the state of all of the processor's variable parameters. A processor can be considered to have high or low activity. This will give some indication as to how dark or light images may be when developed. In the "Micrographic fundamentals" section of this publication, there is a discussion on these parameters, and how they interact, constituting "processor activity."

The purpose of control strips is to provide an image from a known exposure source that does not vary and is from a source other than the microfilmers that are producing production images. This will provide the means of development predictability and help to monitor the development activity of the processor without the question of variability from microfilmed documents.

When production image quality varies, control strips can validate immediately if the source of the problem is from either the processor or microfilmers.

There are two basic types of control strips, *Kodak* Pre-exposed Control Strips and control strips made on a sensitometer, as viewed below in Figure 1.

***Kodak* Pre-exposed control strips**

Sensitometer exposed control strip

Figure 1: Control strips examples

Kodak Pre-exposed control strips

These control strips contain groups of pre-exposed images of 5 circles in successive steps of increasing exposure, see Figure 1. These circles are labeled **LD** (low density), **RD** (reference density), and **HD** (high density). There are 120 sets of exposures on each roll. These densities will be used to monitor the processor activity. The use of these strips to monitor processor activity is outlined in Table 1, page 4. These control strips are available as follows:

Item	CAT No.*	Size
Kodak Microfilm 1461 Control Strips	155 5952	16 mm x 100 ft.
Kodak Microfilm 1461 Control Strips	154 1200	35 mm x 100 ft.

*These CAT Nos. are subject to change by the end of 1999. Contact your local Kodak Representative for details.

Kodak Pre-exposed Control Strips are packaged to protect the pre-exposed film from humidity and moisture. This will minimize image variability and fade from time of manufacture to use.

When a batch is finished, follow the Control Strip Crossover procedure found on page 9 to facilitate the use of another batch. Handling and storage of *Kodak* Pre-exposed Control Strips is outlined on page 10.

Sensitometer exposed control strips

A sensitometer is a device that is used to make consistent, accurate exposures. The exposure time and intensity is highly controlled. The exposure is made through a step tablet that typically produces 20 steps of varying density patches from minimum to maximum density. A particular step and associated density will be used to monitor the activity of a processor. *Sensitometers should be located in darkrooms and used in total darkness with all safelights turned off.*

Process control emulsion

Process control emulsion (PCE) is a batch of film that has an emulsion that is sensitive to processor variations. PCE is provided to customers participating in a *Kodak* Quality Assurance Program.

Another method of providing a control emulsion is to set aside a particular batch of production microfilm emulsion. When this batch is used to create control strips with a sensitometer, it eliminates any variability that might be associated with using multiple batches of emulsions. When

this batch is finished, follow the control strip crossover procedure found on page 9 to use another batch. "Handling and storage of *Kodak* pre-exposed or process control emulsion" is outlined on page 10.

Densitometer

Density is the cornerstone of micrographic processing. The successful use of control strips depends upon accurate density readings. A densitometer is a device that transmits light at a known intensity through a density patch on microfilm. The light transmitted is received by the densitometer and the difference of the transmitted light and the received light is displayed as a numerical density reading. "Proper use and calibration of a densitometer" can be found on page 12.

Process control charts

Maintaining a record of density readings from process control strips is also a key element in proper process control procedures. The analysis of this data is what provides a true understanding of the activity or trends associated with a particular processor. The use of a process control chart is recommended, as this will provide a graphic representation of the activity of a processor. Trends, variations and problems can be easily displayed and analyzed with the use of these charts. The "Using process control charts" section can be found on page 10.

Hydrometer

A hydrometer is a device that measures the dilution (ratio of chemical concentrate to water) of a solution. Whenever water is added to a chemical, the "density" of the solution changes in accordance with how much water is added. This density measurement is expressed as the "specific gravity". This device can be useful to monitor the dilution accuracy and variations of both the developer and fixer. The use of a hydrometer is an important element in a process control procedure and problem resolution effort. The "Use of a hydrometer" is outlined on page 14.

Source document process control procedures

Establishing aims

A processing aim is the density of a particular sensitometer step or the RD value of *Kodak* Pre-exposed Control Strips, which will be monitored. This aim density indicates to an operator that the processor will produce the same quality images before production work is processed. If the aim density varies outside of operating parameters, steps must be taken by the operator to get the processor "back in control" before processing production work.

Establishing "initial aims" is performed for the following reasons:

- implementing process control procedures for the first time
- converting to new type of processing chemicals and/or microfilm
- a new processor is being put into service
- completion of maintenance to a processor which required the processor tanks to be emptied

The procedure on the following page, Table 1, assumes that *Kodak* Pre-exposed Control strips are used, either in conjunction with a sensitometer or not.

It should also be noted that when establishing initial aims, the following procedure should be repeated for each processor and closely monitored for 24 – 48 hours before final initial aim densities are determined. There will most likely be a different process control aim for each processor.

Table 1: Process control setup for *Kodak* Pre-exposed control strips

1. **Set processor parameters for *Kodak* Source Document Microfilms.**

The following parameters are for a deep tank processor (tanks > 5 gal). If a medium or tabletop processor is used, refer to *Kodak* Publication D-30 for the appropriate parameters.

Suggested starting points:

Dilution		**Specific Gravity**	
Developer	1:7	1.045 - 1.055	
Fixer	1:3	1.080 - 1.105	
Dwell Time		48 - 60 seconds	
Temperature			
Chemicals		$85^0 \pm 1$	
Wash Water		$80^0 \pm 4$	
Replenishment	16 mm	35 mm	105 mm
Developer	1.0 mL/ft	2.0	6.0
Fixer	1.25 mL/ft	2.5	7.5

2. **Process 5 pre-exposed control strip exposures.**

Record the average of the 5 LD, RD, and HD densities. The RD value should be 1.0 ± .15. If it is not, adjustments to the dwell time or temperature of the processor should be made.

3. **Repeat step 2 multiple times.**

The average RD value should be within .06 of each other for each run. When this can be repeated 5 times, the processor is considered to be in "initial control".

4. **Process 5 pre-exposed control strips, an exposure step test, consisting of resolution test targets, white paper and samples of production documents. Refer to Figure 2 on page 5.**

Record the exposure setting that puts the white document at 1.0 ±.15. *This density DOES NOT need to match the RD value.*

5. **Critique the quality of the documents. Find the step test exposure that provides acceptable production quality.**

When the quality is acceptable and the white document density is within tolerance:

- the RD value becomes the control aim for this processor
- the white document density is now a reference for the exposure of that particular camera

If the quality and document densities are unacceptable, make adjustments to the exposure of the camera(s) to achieve acceptable results. DO NOT adjust processing parameters to a camera(s).

6. **Perform an exposure test on all cameras to be used.**

7. **Repeat steps 1 through 5 for all processors to be used.**

Process control setup for crossing over control aim to a sensitometer control strip

If a sensitometer is to be used to generate control strips, use the following procedure to cross over the control aim from pre-exposed control strips to sensitometer control strips.

1. Using process control emulsion, make 5 exposures with the sensitometer.
2. Splice together the sensitometer exposures with 5 pre-exposed control strips and process.
3. Make sure the RD value of the pre-exposed control strips is within tolerance.
4. Determine the step on the sensitometer control strip that has the closest density to the RD value of the pre-exposed control strips without going over.
5. This step and density is now the process control aim.
6. Repeat this procedure 3 times and average the results.

Example:

In the following example, when the image quality of production, resolution and white document densities are acceptable, the daily process control aims are:

Pre-exposed control strips, RD value = .93

Sensitometer strips (PCE) = .87, step 10

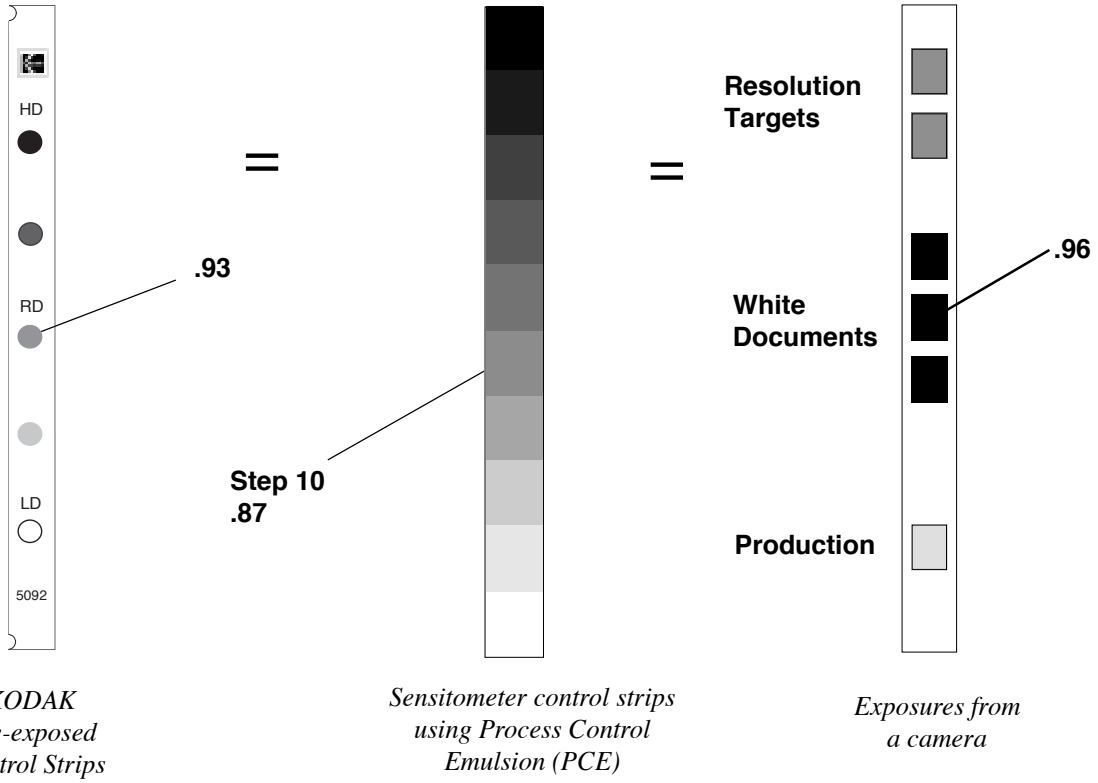


Figure 2: Daily process control aim examples

Daily checks

Processing control limits

Two sets of limits are used to monitor and control the processor(s). There is a control limit and a specification limit. Minor variations are inherent in film and processing and will be evidenced by the fluctuation in density readings obtained from the control strips. The two limits account for such fluctuations and help to determine the appropriate action to take when these limits are exceeded.

Control limit

The control limit is set at ±.06 from the aim. If a density point falls outside this limit, processor parameters should be checked. Processing can continue in this condition as long as efforts are being made to correct the variation.

Specification limits

The specification limit is set at ±.12 from the aim If a density point falls outside this limit, processing should STOP. In the event that this occurs, process several control strips to validate the reading in question.

Daily checks

It is recommended that the following measurements be recorded once for every eight hours of processing operation.

-Developer tank specific gravity

-Developer replenisher rate

-Wash water temperature (incoming to processor)

-Fixer tank specific gravity

-Fixer replenisher rate

The following should be performed no less than 3 times for every 8 hours of processing operation. Typically, control strips are spliced to production work since they are the first to be processed.

1. Record the following on the processor control chart:

   -Date and time

   -Processor speed and/or dwell time

   -Developer/water temperature

2. Using a sensitometer with process control emulsion, make 5 exposures and process. Five *Kodak* Pre-exposed Control Strips can be used separately or in conjunction with the sensitometer control strips
3. Record the average of the control step of the sensitometer strip and/or the average of the LD, RD and HD values of the *Kodak* Pre-exposed Control Strips on a process control chart.

See Figure 4 on page 11 for a control chart with an example of recorded data.

Evaluating results

Immediately after each control strip has been processed, measure the density with a calibrated densitometer. Read densities in the center of the steps.

Within control limits:	NO ACTION
Outside control limits:	Check all processing variables
	Continue to process
Outside spec limits:	STOP processing

Repeat control strip test.

Refer to the following tables to determine corrective actions that apply to certain symptoms. After making any adjustment to the process, the effect should be monitored with additional control strips. The adjustment should be noted on the process control chart.

Resolution / contrast checks

It is also recommended that, on a daily basis, as part of both a process and image quality control procedure, resolution targets be monitored from production microfilmers and processors.

The recommended practice and method of reading resolution targets is outlined in the ANSI Standard, ANSI/AIIM MS23-1997, *Microfilm of Documents, Operational Procedures/Inspection and Quality Control of First-Generation Silver-Gelatin.*

Diagnose and correct an out-of-control process

The following tables will help determine the corrective actions to apply given a certain symptom and the applicable cause. First, review the "General Processing - All Documents", below, to determine if any corrective action can be taken. If this doesn't solve the problem, go to the "Conventional Processing - Source Documents", Table 3.

Table 2: For general processing - all documents

Symptom	Probable Cause	Corrective Action
Control strip RD and LD density value plots are outside of control limits	Densitometer miscalibration	1. Check densitometer to be sure that it is properly calibrated and zeroed. 2. Reread the control strip densities to eliminate reading error as a cause. 3. Examine the Daily Processing Record being kept for the process to determine if a discrepancy is noted. 4. Process, dry, read and plot another control strip. If this plots within control limits, it may be that the readings of the first strip were a result of random additive conditions. Resume processing. 5. If the second control strip confirms the out-of-control condition, check your chemicals (specific gravity), machine conditions (temperature, speed, dwell time) and condition of the unprocessed control strips. 6. If all previous checks fail to find the cause of the out-of-control situation, check the following table for conventional processing symptoms. 7. If all actions in the following table fails to bring densities within tolerance, discard the developer and developer replenisher and mix new solutions. Follow the procedures in “Set up aim densities and tolerances” in this document. 8. If necessary, the densitometer correlation strip provided by the *Kodak* Quality Assurance Laboratory can be used to bring the densitometer back into calibration.

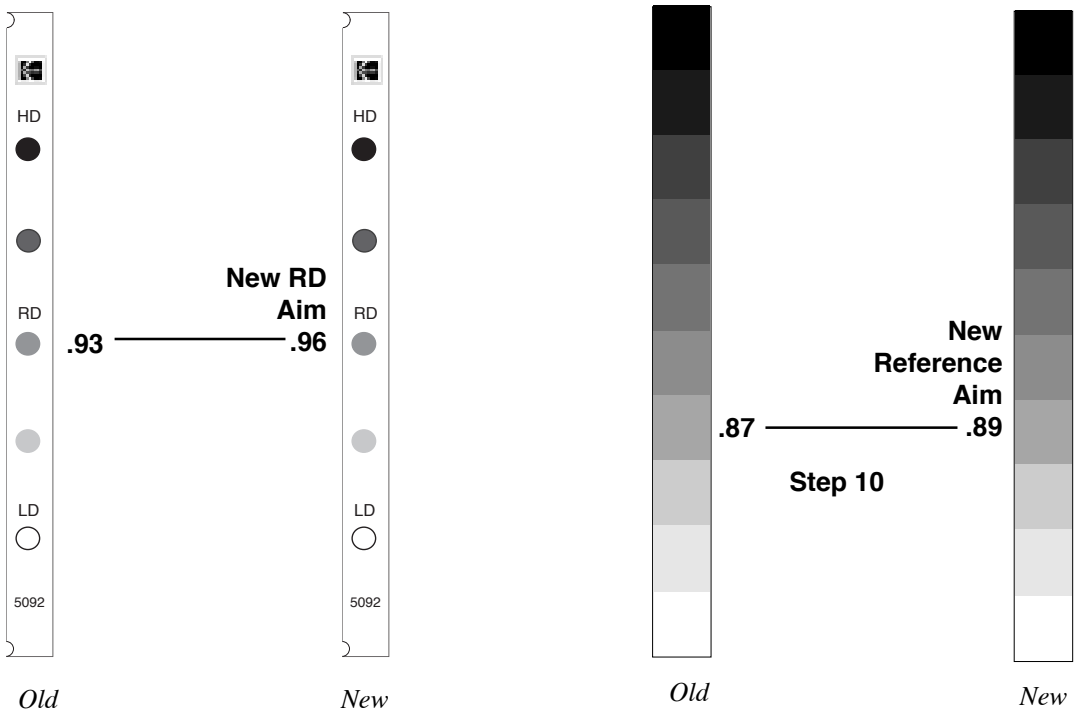
Table 3: For conventional processing - source documents		
Symptom	**Probable Cause**	**Corrective action**
LD & RD plots are too high	• Over-development	• Always check another control strip before attempting correction
High values are repeated after control strip checked	• Fog • Excessive development time and/or slow machine speed • High development temperature • Excessive replenishment	• Check handling and safelight conditions • Re-check all processing parameters; make corrections to these controls
LD is elevated and RD may or may not be affected	• Check for contamination of developer with fixer • Check for fogging due to unsafe darkroom lighting • Possible poor storage of control strips	• Dump the developer and after cleaning the tanks, replace the developer • Check darkroom lighting conditions • Check storage conditions for proper humidity levels
RD plot is too low	• Short development time • Low developer temperature • Too little or no replenishment • Fixer contamination • A processing parameter is drifting	• Re-check all processing parameters and adjust as necessary
Control strip values plot within control limits temporarily, then begin to drift out of the control limits again		• Closely monitor all processing parameters (temperature, speed, dilution). Adjust as unnecessary.

Crossing over new control strips

When a roll of control strips (either pre-exposed or PCE) is nearly exhausted, a new roll should be put into use. Performing a crossover from the current control strip batch in use is done because the new batch of control strip emulsion will not produce the same densities as the current batch. If a crossover is not performed, the variations in densities from batch to batch could indicate an erroneous error condition.

This procedure should be followed to correlate the new control strip density to the old.

1. With existing control strips or Process Control Emulsion, verify the processor is in control and meets current aims. Take corrective action if necessary.
2. Splice together 3 control strips or sensitometer exposures of the current batch with 3 from the new and process.
3. Measure the density of the RD value of the pre-exposed control strip or the aim step density of the sensitometer exposure for both the new and old strips.
4. Verify that the old batch is within tolerances. The new RD value or sensitometer aim step density is now the new control aim.
5. Perform steps 1 – 4 for each processor in use.
6. This crossover and new densities should be noted on the process control chart and/or a new chart should be started for each processor.



KODAK Pre-exposed Control Strips

Sensitometer Exposure on Process Control Emulsion (PCE)

Figure 3: Cross over using pre-exposed control strips or PCE (process control emulsion)

Micrographic processing lab practices

Use, handling and storage of pre-exposed control strips

All control strips, either pre-exposed or process control emulsion used with a sensitometer, should be handled in total darkness. If darkroom safelights are used, these lights should be turned off when handling control strips and/or using a sensitometer.

As covered in the process control section, the pre-exposed strips are packaged for protection against the effects of humidity and moisture on the pre-exposed images. Between each set of exposures, there is a notch on the edge of the film. This is to aid in determining how many sets of exposures will be processed. The emulsion should be oriented in the same direction as the film to be processed.

Rolls of unprocessed control strips should be stored in a refrigerator. It is recommended that no more than an 8 week supply of control strips is stored at once. Rolls can be stored for longer times (up to 6 months) if kept at 0°F (-18°C). When a roll of control strips is to be used, allow the container to stand, unopened at room temperature, for 1 hour to allow all moisture to dissipate.

Recommended control strip practices are as follows:

- Allow film to come to room temperature before use.
- Prepare a work area in the darkroom by laying out a pair of scissors, splicing tape or a stapler, the film, leader or reels that the control strips will be spliced onto.
- Turn off the darkroom lights and safelights.
- Remove the control strips from the packaging.
- Hold the roll so the film is pulled off with emulsion side down.
- Pull the film off the roll and count 5 notches.
- Cut the film directly after the 5th notch.
- Place the roll back in the protective packaging.
- Splice the control strips onto the trailer or film to be processed.

  (If you are unsure which side is the emulsion at this point, hold the film vertically. Feel for the direction of the film curl. Film will always curl towards the emulsion. Or, hold the film horizontally so that the last notch is toward you on the right. The emulsion will now be up).
- Attach 20 - 50 feet of leader to the control strips.
- After the film is either put into a processing cassette or processed, the darkroom lights can be turned on.

Using process control charts

An accurate daily record should be kept of conditions affecting the process. Using a daily record will help establish and maintain processor parameters within acceptable tolerances. As stated earlier, a control chart provides a graphical representation of the processor activity. When process control strips indicate the process is "out of control", these records will be the foundation of a proper problem resolution procedure.

The following guidelines should be considered when using process control charts:

An example of a prepared process control chart is shown in Figure 4.

- A separate chart should be used for each processor.
- The batch or emulsion number of the control strips being used should be recorded on the chart.
- Control strips should be used and recorded at least 3 times every 8 hours.
- Each time control strips are processed, record the current developer temperature, processor speed, date and time.
- Compare the RD, LD or the control step of a sensitometer strip to the aim densities.
- If the control strip's variation is *higher*, plot the difference as a *plus* variation in the appropriate area on the graph. Vice versa if the densities are lower.

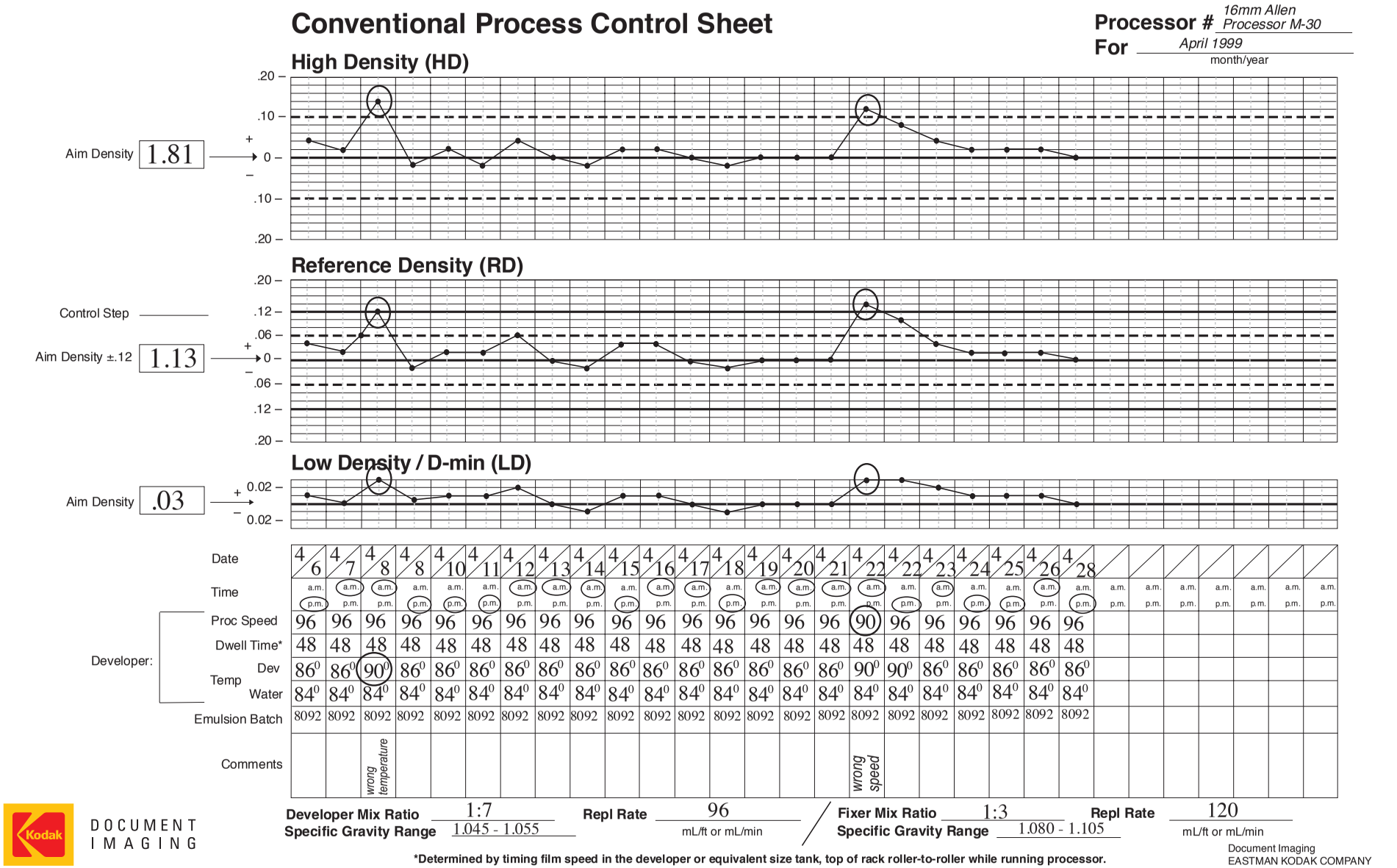


Figure 4: Example of a one-strip reading per plot

- When a control strip crossover is performed or the processor is cleaned and re-filled with fresh chemicals, this should be noted on the control chart with a bold vertical line or a new chart should be started.
- When the aim is changed, start a new process control chart. Process control charts are available through Kodak by ordering A-1630 for the Conventional Process Control Chart (as shown in Figure 4) or a COM Process Control Chart is available as A-1631.

Densitometry

The successful use of control strips depends upon accurate density readings. The densitometer used must be capable of measuring densities with a high degree of accuracy and repeatability. The improper use and maintenance of a densitometer can indicate erroneous processor conditions, which could result in undue loss of production.

Proper use and calibration of a denistometer

Recommended densitometry practices are as follows:

- A densitometer should NOT be located in a darkroom.
- The densitometer should be turned on at the beginning of the day and left on.
- The aperture being used should be the appropriate size for the reduction ratio being measured. As a general practice, the largest aperture that can be used for a given image size provides the best average density of a document or density patch.
- The densitometer-reading surface should be cleaned once a day with a lint free cloth, lightly dampened with water.
- Follow the preventative maintenance schedule provided by the manufacturer.
- Calibrate the densitometer at least once a day. The densitometer should be calibrated with a calibration density patch provided by the manufacturer. If this is not available, a check plaque such as the *Kodak* Transmission Densitometer Check Plaque (CAT. No. 170-1986), can be used. The density strip provided by the *Kodak* Quality Assurance Laboratory is a correlation strip only. This strip is used to correlate the density reading of the densitometer to the densitometer in the *Kodak* Quality Assurance Lab.
- Check the zero of the densitometer before each reading. Variability in readings can result from operating the densitometer too hastily.
- Most densitometers require the densities to be read with the emulsion side up and in the center of the density patch being measured.

Methylene blue testing

The testing for residual thiosulfate (fixer) is a recommended practice to ensure processing is performed to image permanence standards. This test checks that the film is "fixed" and washed correctly and no silver halide remains on the film which could "print up" over time and obliterate information. This test procedure and associated chemicals should never be performed or located near the processing lab area. These chemicals are very photo-active and can cause severe contamination of the processor if inadvertently allowed to migrate into the developer or fixer by physical contact or other means. If this occurs, high D-min and/or high density spots will be observed. The only cure for this is a complete processor cleaning.

The Residual Thiosulfate level of microfilm is determined by the methylene blue test, which conforms to the ANSI Standard, ANSI/NAPM IT9.17-1993 (*Photography - Determination of Residual Thiosulfate and Other Related Chemicals in Processed Photographic Material - methods Using Iodine-Amylose, Methylene Blue and Silver Sulfide*.) It is an accurate method for measuring the amount of thiosulfate ion that remains in the film after processing. See Table 4, page 19, for instructions on how to do this test.

The amount of residual thiosulfate actually determined to be present in the film is recorded as described in Table 4. The clear (minimum density) portions of the processed film are used for the methylene blue test. The archival limit is <1.4 micrograms/cm^2 S203= (i.e. 1.4 micrograms of thiosulfate per square centimeter) as established by ANSI/NAPM IT9.17-1993.

Safelights

Safelights are used as a common practice to provide a safe working environment in either a dark room or processing environment. The proper use of safelights is a contributing practice to the production of high quality and consistent images. The following chart outlines the proper use of safelights for various microfilms.

Type of film	Safelight	Bulb*
Kodak IMAGELINK HQ, FS, CS, CP and Archive Storage Media	*Kodak* No. 3 Green Filter	7.5 watt bulb, min. 6 to 8 feet (1.8 to 2.4 meters)
Kodak Duplicating Microfilms x468 and 2470	*Kodak* No. 1 Red or No. 2 Dark Red Filter	15 watt bulb, min. 4 feet (1.2 meters)
Kodak Duplicating Microfilms x440 and x462	*Kodak* OA Greenish Yellow Filter	15 watt bulb, min. 4 feet (1.2 meters)
Kodak Diazo, Vesicular Microfilms	Can be used in room light	
Kodak COM DR Microfilm	*Kodak* No. 1 Red Filter	15 watt bulb, min. 4 feet (1.2 meters)

*distance from work surface

Chemical mixing and storage

Proper chemical mixing procedures are key factors in obtaining desirable repeatable results. It is often difficult to diagnose incorrect or inconsistent mixed solutions, which may increase production costs. For best results, follow these recommended practices:

- Mixing equipment that comes in contact with processing solutions should be made of chemically inert materials. This includes plumbing, mixing devices and processor filters.
- Always mix chemicals with filtered water at room temperature.
- A 5-micron size filter is recommended for incoming water filtration. Water quality is very important for proper chemical mixing.
- *For safety and proper mixing, implement-mixing procedures that will add chemicals to water, not water to chemicals.* This reduces the possibility of chemical concentrates from splashing on clothes or operator's skin.
- Thoroughly clean all mixing equipment with water immediately after use. This will prevent cross contamination when the next solution is mixed.
- If possible, use different mixing and filling equipment for developer and fixer.
- Provide dust covers for solution storage tanks.
- Whenever possible, protect solutions with floating lids in addition to dust covers. These lids help to minimize oxidation and evaporation.
- Check valves should be installed between the processor and the replenisher unit to help prevent discharge when either the processor or replenishment unit is being serviced.
- Only mix and store enough working solution that will be used in a 72 hour time period.
- All mixed solutions should be stored at room temperature, between 65° and 80° F. Storing mixed solutions at either too high or low temperatures may cause the chemicals to become inefficient and produce undesirable results.
- Always keep lids and caps of chemical concentrate containers on tight and avoid intermixing the caps or lids.
- Processing equipment must be free from corrosion and chemical deposits. Encrusted deposits that accumulate can cause chemical contamination and scratches on processed film. Deposits that are difficult to remove by conventional cleaning can be removed by using the proper systems cleaner such as *Kodak* Liquid Developer System Cleaner (CAT No. 101-3176) and *Kodak* Fixer/Wash System Cleaner (CAT No. 139-5110).

Use of a hydrometer

As stated in the overview section, a hydrometer is a device that measures the dilution (ratio of chemical concentrate to water) of a solution, see Figure 5. This measurement is expressed as the "specific gravity". This device can be useful to monitor the dilution accuracy and variations of both the developer and fixer. The hydrometer can be used to check the specific gravity directly in the processor tanks and the holding tanks of the replenishment system.

- Use a hydrometer with a graduated scale range from 1.0 – 1.220
- Turn off the processor recirculating pumps
- Place the hydrometer in the processor tank or replenisher holding tan
- The hydrometer will bob and float. When the hydrometer settles, read the graduation at the solution line to determine the specific gravity.
- Solution can also be taken from the processor tank or replenisher holding tank and put in a graduated cylinder for reading
- Wash off the hydrometer with water after each reading. This will avoid cross contamination.

Specific Gravity Aims		
Mix ratio	Microfilm Developer	Microfilm Fixer
1:3	n/a	1.085-1.105
1:7	1.045 - 1.055	n/a

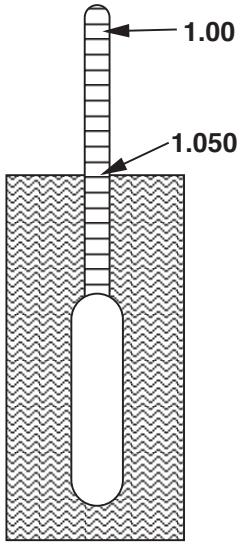


Figure 5: Hydrometer example

Micrographic fundamentals

Image capture

As previously stated, image capture devices are adjusted to yield optimum image quality in accordance with the processor(s) that will be used to develop the image. The function of microfilm processing is to obtain an image that can be read, duplicated and possibly copied and/or enlarged. It is beneficial to have a basic understanding of how the image is captured and developed.

Simply put, microfilming involves a subject document, a light source, a lens, a shutter and film. During exposure, the shutter of a camera opens to allow light to strike the film. Light is projected onto the document. The background of the document is typically brighter and reflects much more light than the characters of the actual image to be captured. The reflected light from the background of the document is reflected through a reduction lens and onto the microfilm. The light that strikes the film turns the silver halide into microscopic silver metallic specks, invisible to the human eye. So, in actuality, when a document is microfilmed it is the background of the document that is being photographed. This image is referred to as the "latent image". Exposed, yet undeveloped.

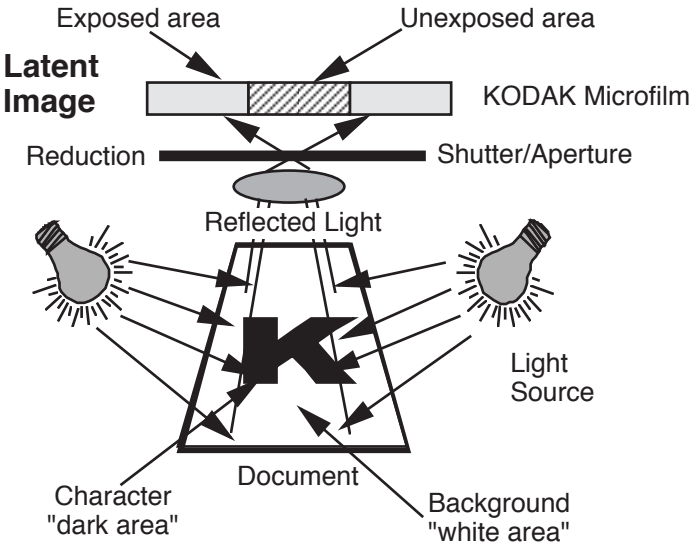


Figure 6: Latent image example

Image development

When the microfilm is developed, the chemicals in the developer cause a chemical reaction. The exposed silver halide (background) is amplified and turns to black metallic silver, which is now visible. The unexposed silver halide (characters) is unaffected. The film is then put in a fixer bath. Fixer is a chemical (thiosulfate) that dissolves unexposed and undeveloped silver halide (characters). The "optimizing" of an image is the process of determining how much light to use, which the background of the document will reflect. Therefore, when developed, there is a "balance" between background density and character clarity.

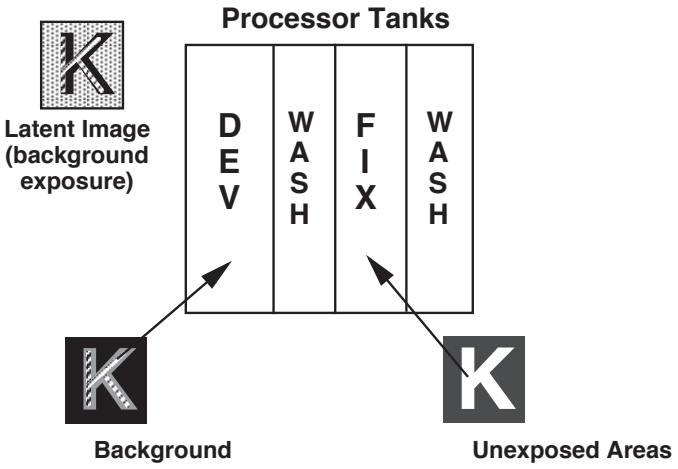


Figure 7: Typical conventional image development process

Processing

Processing is the development of the latent image to acceptable standards and treating the film so that the image will meet image permanence standards. The processor is the device that will control the development process. Conventional source document processing is primarily achieved by using two basic chemicals—developer and fixer. The combined use of the chemicals, along with water for washing and heat for drying, is what comprises "processing". A discussion of the fundamental process by which most microfilm is processed follows:

Develop

Developer is a combination of chemicals that turn exposed silver halide crystals (latent image) into visible black metallic silver.

Wash

The purpose of the wash is to stop the previous chemical reaction and to clean the film before entering the next chemical bath.

Fix

Fixer is a chemical (thiosulfate) which dissolves any undeveloped (unexposed) silver halide.

Wash/rinse

The purpose of the final wash/rinse is to remove all remaining chemicals that may be left on the film. This step is critical in achieving proper image permanence. If residual chemicals remain on the film, the image can deteriorate over time. (See Image permanence, page 17, for more information.)

Dry

Proper drying of the film is important as it eliminates any remaining moisture on the film. If the film is not dried properly, water spots may be observed. Moisture can also cause the destruction and/or removal of the emulsion during winding and unwinding of the film.

Processing parameters

Proper processing and process control is achieved by establishing and monitoring processing parameters. The film manufacturer specifies most parameters that will achieve acceptable film production quality. The combination of these parameters is often referred to as "process activity". The activity refers to the degree to which the film is developed, either high (fast) or low (slow) activity. These parameters are defined as follows:

Dwell time

The amount of time required to transport the film through a chemical bath or processor tank. Film manufacturers do not know the type or size of the processor to be used. Therefore, the manufacturer will specify the time (dwell) which is required for proper development of a film. This dwell time will be later translated into feet per minute by the processor specifications.

Temperature

The temperature of a chemical, specifically the developer, will affect how quickly an image will be formed. The temperature cannot be too high or low, as it will directly affect image quality and all other processor parameters.

Dilution

This is the ratio to which chemical concentrates are added to water. Dilution is expressed in terms of ratios such as 1:7. This indicates the chemical is diluted with 1 part concentrate to 7 parts water.

Replenishment

This is the process by which fresh chemical "working solutions" (diluted) are added to the appropriate chemical tank in a processor while processing film. The rate at which this is to be done will be specified by the film manufacturer and determined by the speed (dwell time) at which the processor is operating.

Establishing processing parameters example

Use the specification chart provided by the processor manufacturer to determine developer and fixer, dwell times and temperature. The formula below will determine the developer and fixer replenishment rates (mL/min) by multiplying transport speed (ft/min) (which is determined by dividing the path length of the developer tank in feet by the dwell time in seconds and multiplying by 60; see example) and the appropriate processor replenishment specification (mL/linear ft).

Transport speed (ft/min)	**X**	**Replenishment/ ft of film (mL/Lft)**	**=**	**Replenishment rate (mL/min*)**

*1 mL/min = 1 cc/min

An example follows:

For processor: *Allen M-70*
Type of film: 16 mm *Kodak Imagelink* HQ
Dwell: 43 seconds
Dev Film Path: 154 feet

See chemical manufacturer specification table for:

Replenishment (Dev): 1 ml/ft
Replenishment (Fix): 1.25 ml/ft

Note: These are starting point parameters for a deep tank processor, referred to in Table 1, page 4. For the replenishment parameters for other deep tank, medium or tabletop processors refer to the appropriate *Kodak* Dataletter.

Calculated transport speed:

$$\frac{154 \text{ feet}}{43 \cancel{\text{sec}}} \times \frac{60 \cancel{\text{sec}}}{1 \text{ min}} = 215 \text{ feet / min (transport speed)}$$

$$\frac{215 \cancel{\text{feet}}}{\text{min}} \times \frac{1.0 \text{ mL}}{\cancel{\text{feet}}} = 215 \text{ mL / min (replenishment rate)}$$

Replenishment rate results:

215 feet x 1 = 215 mL/linear foot for developer
215 feet x 1.25 = 268 mL/linear foot for fixer

Interaction of processing parameters

Each processing parameter directly affects image quality and/or other parameters. The following chart illustrates the interaction of the parameters.

Parameter:	High	Low
Dilution	light image (lower density)	dark image (high D-min)
Temperature	dark image (high D-min) (high background density)	light image (low density)
Transport speed	light image (low D-max)	dark image (high D-min)
Replenishment		
Developer:	unstable densities	light image
Fixer:	waste money	"smoky" film residual silver

Other considerations

Wash water

The wash water entering a processor should be filtered and temperature controlled. Typically, the temperature of the wash water should be 5^0 F (2^0-3^0 C) lower than the developer temperature. In addition, the rate at which the water flows to the processor should be monitored and maintained to the processor manufacturer specifications.

Use of a stop bath

Although not commonly used, a stop bath can also be used between developer and fixer. The function of the stop bath or rinse (when used) is to stop development, prevent stains and help preserve the life of the fixing bath. When using an acid stop bath, a certain level of acidity should be maintained.

If the pH of the tank solution is less than 4.0, check to see if the stop bath replenishment rate is too high. If the pH is more than 5.0, check to see if the replenishment rate is too low or if the developer carry-over is higher than usual. If replenishment and carry-over rates are correct, check the pH of the replenisher solution.

When *Kodak* Indicator Stop Bath (CAT No. 146-4247 - 16 oz or 140-8731 - 1 gal) is used, its condition can be checked easily because the bath changes color when exhausted. By room light, fresh bath is light yellow; it changes to purple-blue when exhausted.

Silver recovery

The recovery of silver from exhausted fixers or replenishment overflows usually offers monetary savings and other benefits. For more detailed information concerning silver recovery, write to *Kodak* Environmental Services, Eastman Kodak Company, 343 State Street, Rochester, New York 14652-6255, call (716) 477-3194 or visit the *Kodak* Environmental Services Web Site at http://www.kodak.com/go/kes. *Kodak* Publication No. J-212 may be obtained for a discussion on the technology of silver recovery.

Drying temperature

The film manufacturer specifies proper drying temperature. Most processors provide the capability to adjust the drying temperature. If multiple film widths are used, the drying temperature should be adjusted to the setting that provides proper drying of the widest film.

Image permanence

Most of the film requirements for long-term storage of ANSI Standards cannot be controlled by the film manufacturer. They are the responsibility of the user storing the film. The residual thiosulfate level of the processed film is the principal factor governed by processing. Satisfactory performance requires that *both* fixing and washing be adequate. In order to prevent eventual staining or image degradation.

If long-term storage is required, residual thiosulfate levels should be determined by the methylene blue method. The silver densitometric method is less accurate. The use of a *Kodak* Hypo Test Kit (CAT No. 196-5847) is simple and convenient. However, the test is not very accurate at the level required for long-term storage and should not be used as a primary test for thiosulfate content. For those who prefer not to do their own testing, commercial laboratories are available to test for residual thiosulfate.

Methylene blue analysis procedures

The following table, Table 4, page 19, steps you through the methylene blue testing procedure. To be valid, the sample must be tested within 2 weeks of the time of processing. However, laboratories subscribing to programs with the *Kodak* Quality Assurance Laboratory, will conduct the tests immediately after the film is processed. Only emergency situations should delay the test longer than several hours. All processed silver gelatin films are subject to the test. It must be performed once a day prior to shipping films processed that day.

The *Kodak* Quality Assurance Laboratory provides, as part of their programs, the Solutions A, B, C, D and E that are referred to in the following preparations.

Methylene blue test preparations

WARNING: Safety goggles, gloves and lab coat must be worn while handling any chemicals.

Prepare the borohydride reagent (Solution B) by dissolving two pillows of potassium borohydride in 20 mL of 0.2N sodium hydroxide, NaOH (or one pillow of potassium borohydride per 10 mL of 0.2N sodium hydroxide, if more is required), and pour the mixture into a dropping bottle. This reagent is stable for one week in a cool place. At the end of one week, discard any remaining solution and remix. Should the volume of solution become too low to permit easy filling from the dropping bottle, it may be transferred to a small beaker during the day, but should be replaced in the dropping bottle at the end of the day.

Fill the labeled dropping bottles with the reagents supplied to you from the *Kodak* Quality Assurance Lab. Empty the 1 litre bottle of eluent (Solution A) into the automatic dispenser bottle supplied in your initial kit. Arrange the bottles in the order to be used, from left to right, in front of you on a clean lab bench or table. Since you have already mixed the potassium borohydride pillows with the hydroxide, the order of solutions from left to right should be as follows:

Solution A - Eluent (in glass dispenser)

Solution B - Borohydride Reagent

Solution C - Acetone

Solution D - Ferric Sulfate Reagent

Solution E - NND Reagent

Turn on your spectrophotometer and allow 10-15 minutes to warm-up. Make sure that the red sensitive phototube and the filter have been installed and that the wavelength setting is at 665 nm (nanometers). Consult the instruction book accompanying your spectrophotometer.

CAUTION: Wash hands thoroughly before handling film. Check to see that the work area and all glassware are clean. Contamination renders the test useless. Be aware that potassium borohydride is a health hazard and a strong film contaminant.

Table 4: Methylene blue test procedures

1. Obtain a 10-square centimeter sample, taken from a clear or minimum density area of the 16 mm or 35 mm film to be tested. Use the 16 mm template.

   Fold the film into a W-shape and place it in a 3 dram-shell vial. Using the automatic dispenser, add 5 mL of the eluent (Solution A) to the vial. Allow the solution to stand for 10 minutes with occasional swirling. Remove the film sample with tweezers, being careful to drain the sample into the vial.

2. Add 5 drops of the borohydride reagent (Solution B) to the vial and swirl the mixture. (Caution: continue immediately and complete the next 2 steps within 15 seconds)

3. Add 10 drops of acetone (Solution C) to the vial and swirl to mix.

4. Add 5 drops of ferric sulfate (Solution D) to the vial followed by 5 drops of NND (Solution E). Cap *immediately*. It is not necessary to swirl the mixture between the addition of Solutions D and E.

5. **Caution:** Hold the cap on very firm, using the thumbs of both hands, and shake the vial vigorously for 5 seconds. Vent the pressure formed by an evolved hydrogen; you may hear a "popping" sound as the cap is released. Wear safety goggles, gloves and a lab coat to protect yourself in case of spillage.

   Cap the vial once more and shake vigorously for another 30 seconds, then vent again. If the pressure pops the cap loose prematurely and solution spills during the agitation procedure, the test must be repeated. (Shake a total of 1 minute). Also vent at end of one minute. **Note:** you will observe the color of the solution going through a red stage as soon as you cap it the first time. (If the red color fails to form, a very high level of thiosulfate is indicated.)

6. Allow the test solution to stand for 5 minutes to permit any trace of red color to disappear before taking a reading.

7. Use an empty spectrophotometer test tube to zero your spectrophotometer, which has been set for 665 nanometers. Pour the test solution from the shell vial into another clear test tube and read the "Absorbance" (optical density) on your spectrophotometer scale.

8. Read the density obtained on the left side of your calibration curve. Follow this point in a straight line to the right until it intersects the curve, then read straight down to obtain the microgram/cm^2 S203=.

9. Record the figure obtained on the form.

Residual thiosulfate

Record results of the Residual Thiosulfate Test in terms of "less than (<) 1.4) or "more than (>) 1.4 micrograms) of thiosulfate ion-per-square centimeter of processed film.

Cleaning

Wash all shell vials, beakers, test tubes, etc., in glassware cleaning solution and rinse thoroughly in tap water. Repeat rinsing three times with distilled water, and air dry.

CAUTION: DO NOT USE BRUSHES to clean spectrophotometer test tubes. The tubes will become scratched and unfit for use.

Image optimization procedures for diazo, vesicular and silver microfilm duplication

Diazo duplication

Image formation

Diazo microfilm is a polyester-based film that uses diazonium salts combined with a dye coupler to form a strongly colored dye. Diazo microfilm is a sign maintaining film. A negative appearing image is produced from a negative appearing original. The diazo duplication process employs a contact printing method. The emulsion of the silver original is brought in contact with the emulsion of the diazo microfilm. Ultraviolet light is projected through the base of the original. The clear area of the original (characters, D-min) film passes the ultraviolet light to the diazo microfilm. Where exposed to the ultraviolet light, the diazonium salts decompose. When the diazo film is subjected to heat and ammonia vapors, the areas protected from ultraviolet light by the background densities of the original image, will react and the dyes will be released forming the strongly colored background. The areas where the diazonium salts decomposed will not release dyes and this becomes the D-min, or characters of the diazo duplicate.

As with any development process, controlling the variables is key to maintaining high image quality on a consistent basis. See Table 5 for the procedure on how to optimize the performance of a diazo duplicator and control the image development variables.

Vesicular duplication

Image formation

Vesicular film is similar to diazo in that this film is also a polyester-based film that utilizes diazonium salts. In vesicular film, these salts are coated into a plastic layer (polymer). Vesicular, however, does not use dyes or require the use of ammonia in the image formation process. Vesicular film is typically used to create a positive appearing duplicate from a negative appearing original. Vesicular film is also used in COM to make negative appearing fiche from a positive appearing COM master. Refer to Figure 8 for establishing crossover aims for vesicular duplicates.

Vesicular duplication is also a contact printing process. The emulsion of the silver original is brought in contact with the emulsion of the vesicular film. Ultraviolet light is projected through the base of the original. The clear area of the original film passes the ultraviolet light to the vesicular film. Where exposed to the ultraviolet light, the diazonium salts decompose forming nitrogen. When exposed to heat, the plastic layer softens. The nitrogen expands and forms microscopic bubbles (vesicles). These vesicles are what create the image (density) by scattering light when projected on a screen. Where no ultraviolet light hits the film, the film remains unchanged. This area is “cleared out” causing D-min by re-exposure to ultraviolet light.

Table 5: Optimizing diazo image quality procedures	
1. Evaluate image quality of duplicate	• D-min - characters clear, hazy, dim • Background density - Use a white document (target)
2. Evaluate background color (in a reader)	• Blue diazo is less susceptible to development temperature variations • For black or tonal diazo microfilms: - Bluish appearance means temperature is too high - Brown/sepia appearance means temperature is too low - Green/yellow appearance means ammonia starvation
3. Temperature sensitive strips can also be used	• Apply on diazo film and process • After processing, read the greatest value temperature box which is darkened
4. Measuring true D-max of raw film	• Cut an 8" piece of film from a fresh roll • Feed 6" into the development chamber • Allow film to develop 60 - 90 seconds • D-max should be approximately 1.5 - 1.65 for black and blue • D-max should be approximately 1.15 - 1.25 for tonal
5. Quantify machine speed	• Record the time required to run a known length of film - Use 100' or 215' roll of camera film $\frac{\text{Length of film}}{\text{seconds}} \times 60 = \text{feet /minute}$
6. Determining optimal machine speed	• Duplicate a silver step wedge with known densities .05 - 2.0 (.15 increments) at various duplicator speeds • The silver D-min (.05) should reproduce to < .07 • The .35 step should reproduce to .30 - .35 (D-max at optimal machine speed should be 90% of D-max measured in step 4)
6a. Determining optimal machine speed Alternate method:	• Punch a hole in clear silver original • Run the duplicator at normal duplicating speed and duplicate film with hole • "Printed D-min" inside of hole should be .01 less in density than surrounding the hole • If D-min inside of hole is greater, then reduce transport speed to compensate for running too fast (low exposure)

Vesicular image optimization and control

Vesicular image optimization is systematic. The only variables in this process are exposure and heat. The process to establish and maintain duplicate quality is relatively simple. Also, vesicular image optimization is dependent on the subject matter and quality of the original image. In any case, the following simple guidelines can be useful:

1. Use production master film and perform an exposure series on the vesicular duplicator.
2. Find the exposure setting that yields the optimum image quality for the application being duplicated (either positive or negative). Do this for all the different applications and reduction ratios to be duplicated on a regular basis.
3. At this setting, duplicate a processed pre-exposed control strip that falls within processing tolerances. Note the LD and HD values. These will now become the control aims for all the duplicators.
4. Duplicate a control strip on all the duplicators to be used and adjust as necessary. Repeat this procedure once each day with a control strip from the processor generating the Masters.

Note: Densities of vesicular film should be measured with a densitometer in the projection mode.

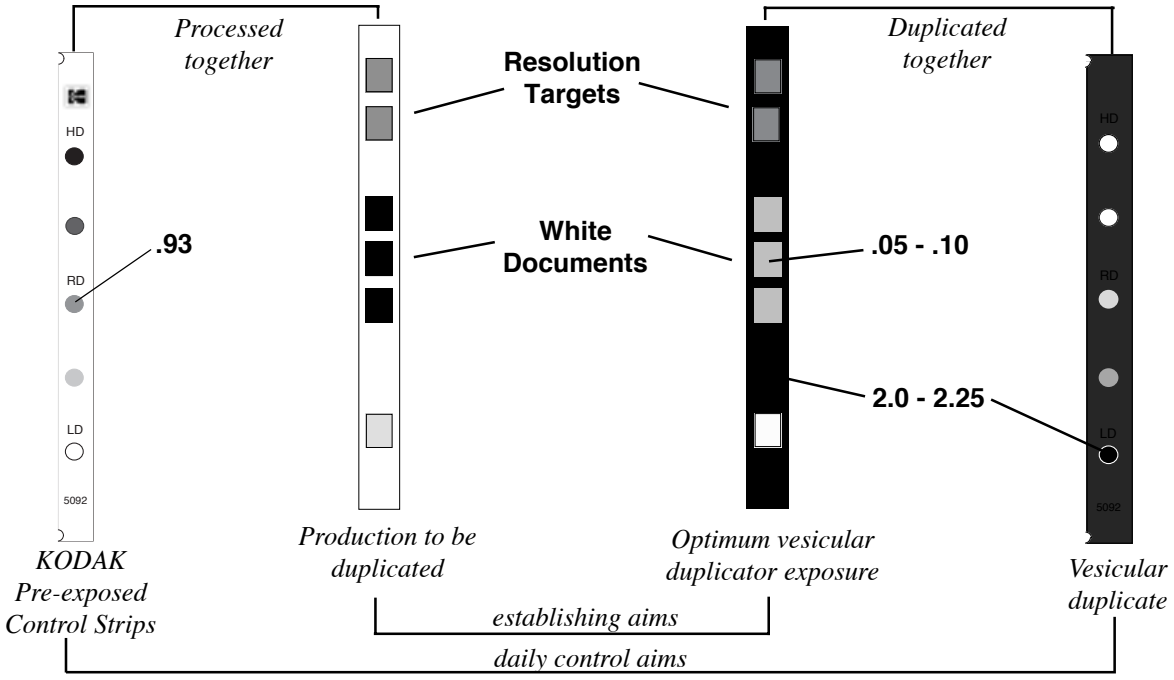


Figure 8: Establishing crossover aims for vesicular duplicates

Silver duplication

Silver duplicating microfilm uses silver halide as the image formation component and is constructed much like the camera microfilm used in standard microfilmers. Silver duplicating microfilm is used and preferred when the following attributes are desired:

- very high quality images
- image permanence requirements that meet original silver microfilm **L**ife **E**xpectancy ratings (LE-500)
- ability to control and manipulate original image polarity, contrast and resolution
- conversion of formats; 16 mm strips to fiche, 35 mm to 16 mm, etc.
- conversion of acetate-based film to polyester-based film

There are two basic types of silver duplicating microfilm — Direct Duplicating and Duplicating (Print) Microfilm. The Direct Duplicating films maintain the original image polarity (negative-to-negative or positive-to-positive). The Print Duplicating films reverse the original image (negative-to-positive or positive-to-negative). Although silver duplicating films function the same as camera films, they are photographically much slower due to the amount of light that is used in the duplication process. Safelights can be used when handling these films. The appropriate safelights for these films are discussed on page 13 of this publication.

Kodak offers four different types of silver duplicating microfilms. Each has a unique feature that provides high quality and consistent duplicated images. When images are duplicated on these films, the contrast of the image increases in proportion with the contrast of the duplicating film. Additionally, all *Kodak* Silver Duplicating Microfilms are processed with the same chemicals as *Kodak* Camera Negative Microfilms. However, the processor conditions do vary from camera film parameters. A discussion on processing these duplicating microfilms is found below or refer to *Kodak* Dataletter D-32.

An overview of each duplicating microfilm follows:

Kodak Direct Duplicating Microfilm x468

This direct duplicating film has contrast and speed qualities that provide very high quality duplicates from the widest variety of original images.

Kodak Direct Duplicating Intermediate Microfilm 2470

When multiple copies of an original camera microfilm are required, an intermediate master is used so that the original is protected from becoming damaged in the duplication process. This unique film is specially designed with physical and photographic qualities that provide multiple copies with very high quality. If an intermediate master is used that has contrast consistent with typical duplicating film, the resulting image can become too high in contrast with a loss of resolution. Direct Duplicating Intermediate Microfilm 2470 is a very low contrast film that enables the contrast of the distribution duplicate to be closer to the original than if other typical distribution direct duplicate microfilms were used as an intermediate.

Kodak Duplicating Microfilm x462

This film is typically used to make positive appearing images from negative appearing masters or intermediates. Positive images are preferred when viewing images with photographs and when original image appearance is desired. This film can also be used as an intermediate to make negative appearing duplicates (negative-to-positive-to-negative), however this is not recommended.

Kodak Duplicating Microfilm Positive Print x440

This film is used for the same purpose as the x462 duplicating film, however, it is lower contrast, faster speed, higher D-max and provides more of a neutral image tone. This film is preferred when either poor quality originals or documents with low contrast images require duplication.

Processing of silver duplicating microfilm

The processing parameters for silver duplicating microfilm differ from the parameters for camera film. These films use more photographic dyes and require sufficient washing to remove them. Therefore, it will require a longer dwell time (slower transport speed) to provide both proper

image development and washing. The recommended dwell times for these films using deep tank processing are as follows:

Type of microfilm	Dwell time*
x468, 2470	90 seconds
x462, x440	68 seconds

*These dwell times are recommended starting points only.

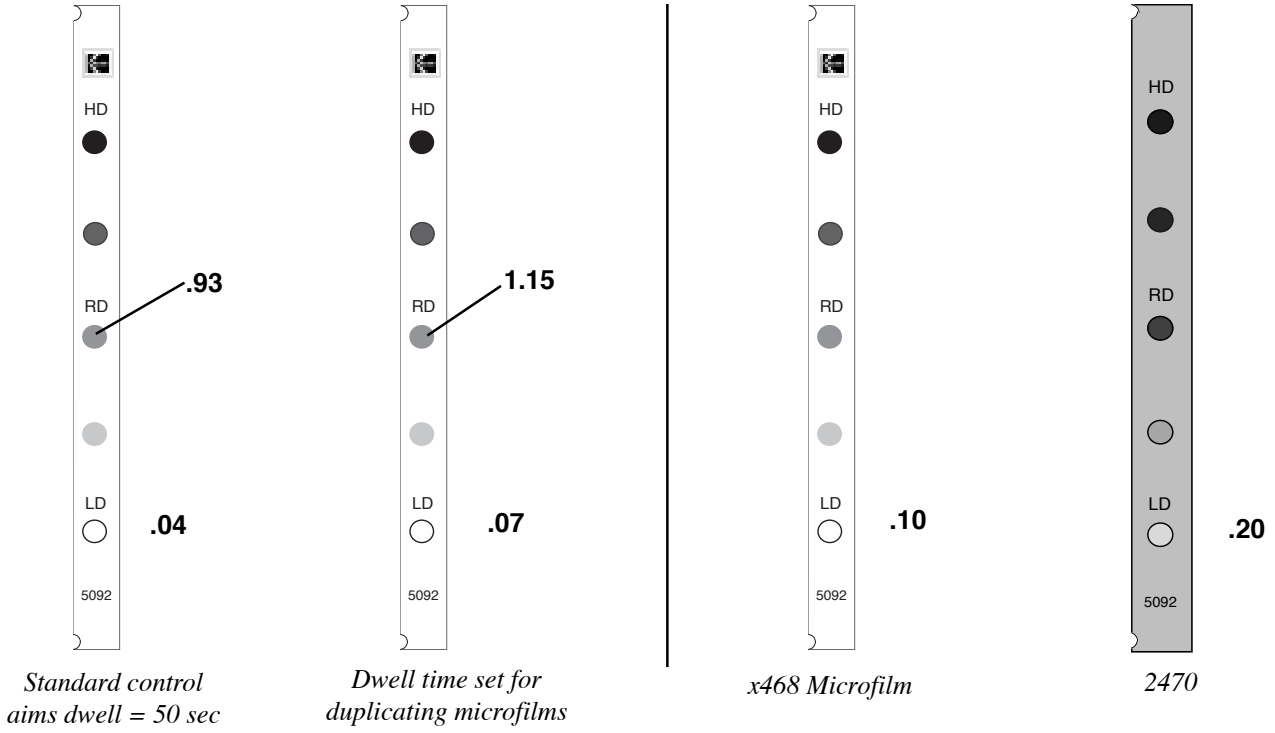
The processing parameters for silver duplicating microfilm being used in a deep tank processor differs from the parameters for camera negative microfilms. A longer dwell time is used to provide proper washing and removal of photographic dyes. The recommended dwell times for deep tank processors are recommended starting points to achieve similar photographic properties when processed in a *Kodak Prostar* Processor. It should be noted that when processing a high volume of microfilms (>25, 30m rolls/day) in a tabletop processor, increased wash water volume and/or increased replenishment rates may be required to reduce residual photographic dye stain. Also, the developer and fixer tanks should be cleaned and washed more frequently.

Shorter dwell times can be achieved by adjusting the duplicator exposure and transport speed. If this is the case, establish LD and RD aims for this setting. In some cases, it is desired to use the same processor settings as camera microfilm. This can be done, however, once desired processor settings are established. Both microfilm camera and duplicator exposure settings should be set to the processor's parameters.

Daily checks - Direct Duplicating Microfilm x468 and 2470

1. Using *Kodak* Pre-exposed Control Strips or a sensitometer exposure, ensure the processor activity is within aim tolerances. Do not use duplicating films with a sensitometer. Use a process control emulsion or equivalent. Make adjustments to processor parameters as necessary.

Note: If a different transport speed is used for duplicating film, set the processor to this speed and verify processor activity based established aims for this setting. Make adjustments to processor parameters as necessary.



Standard control aims dwell = 50 sec

Dwell time set for duplicating microfilms

x468 Microfilm

2470

Figure 9: x468 and 2470 setups for establishing aims

2. Using the control strip from step 1, duplicate the control strip and process.

3. Check the LD value (D-min) density values:

X468: .10 ± .02
2470: .20 ± .03

If these densities are not met, make adjustments to the duplicator exposure until they are within tolerance.

4. Check that the LD, HD or sensitometer control step densities are within established control aim densities.

5. Repeat steps 1 – 4 for each duplicator being used.

The following table, Table 6, is an example that can aid in the determination of which Direct Duplicating Microfilm to use and to what density the D-min should be printed to, based on the original microfilm image quality.

Print masters

A print master is used when making multiple duplicates of the original so that the original is protected from damage in the duplication process. Also, when an original is of poor quality, a print master is used to manipulate the image quality. *Kodak* Direct Duplicating Intermediate Microfilm 2470 is a product designed specifically for this purpose. The following guidelines, along with Table 6, should be followed when making print masters.

- When duplicating images, the photographic contrast of the image will always multiply by the contrast rating of the duplicating film.
- The D-min of the intermediate print master should always be higher than the D-min of the original. Doing this puts the original image's photographic range in the controllable range of the intermediate film.
- The most basic and misunderstood principle when using *Kodak* Direct Duplicating Microfilm is that exposures should be set to achieve the proper D-min and NOT to achieve the same image background density of the original image. Trying to "match background" densities of the original will compromise the

Table 6: Intermediate microfilms - duplication guidelines

Orig	1N (original) background densities					
	Light		Medium		Dark	
D-min	**< .85**		**.85 - 1.25**		**> 1.25**	
between frames	**Film**	**D-min aim**	**Film**	**D-min aim**	**Film**	**D-min aim**
< .08	2468	.11 to .13	2470	.18 to .22	2470	.14 to .18
.09 - .12	2468	.13 to .15	2470	.18 to .22	2470	.14 to .18
.13 - .16	2468	.15 to .17	2470	.18 to .22	2470	.16 to .20
.17 - .20	2468	.17 to .19	2470	.22 to .24	2470	.18 to .22
.21 - .25	2468	.19 to .21	2470	.26 to .30	2470	.20 to .24

NOTE: Use this chart to set the D-min aim when making an intermediate print master.

image quality of the ultimate duplicate. As exposure is increased to bring background densities down, the D-min (characters) "bottom out" and start to bloom or become fat.

- Remember, if the original is to be duplicated and then destroyed, make a proper print master and do not attempt to exactly replicate the original.

Establishing aims and daily checks - *Kodak* Duplicating Microfilm x462 and x440

1. Using *Kodak* Pre-exposed Control Strips or a sensitometer exposure, ensure the processor activity is within aim tolerances. Do not use duplicating film with a sensitometer. Use a process control emulsion or equivalent. Make adjustments to processor parameters, as necessary.

Note: If a different transport speed is used for duplicating film, set the processor to this speed and verify processor activity based on established aims for this setting. Make adjustments to processor parameters as necessary.

2. Using the control strip from step 1 and production work exposed and processed to the aims, perform an exposure series on the duplicator and process.
3. The white document density will now be the density that produces the "printed D-min" on these films. Look for the duplicator setting that yields a D-min of .06 - .10 from the density of the white document.
4. At the setting from step 3, critique the image quality of the characters and photographs. If the image quality is acceptable, the RD and LD (now D-max) values become the daily control aims.
5. On a daily basis, duplicate and process a control strip from a "stable" processor on each duplicator. Make minor adjustments to the duplicator exposure to bring the duplicated control strip aims within tolerance.

In the example below:

Daily Duplicator aims:

Duplicated Control Strip LD aim: 1.4

Duplicated Control Strip RD aim: . 13

(at duplicator setting x)

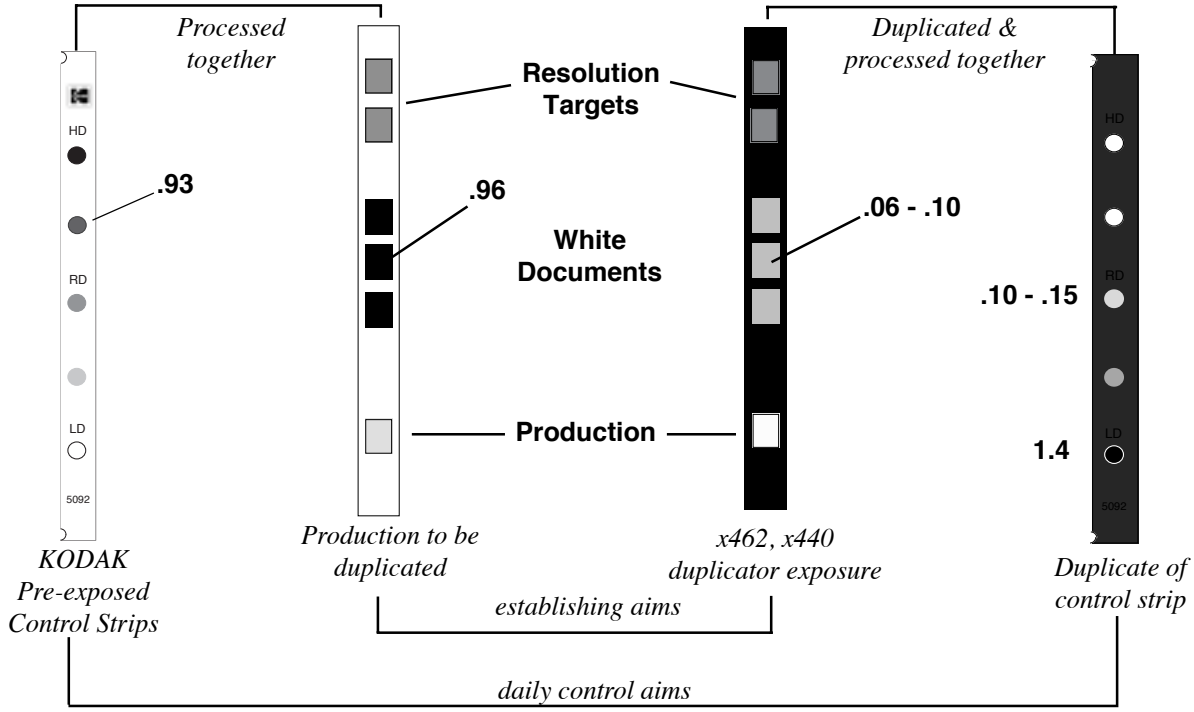


Figure 10: x462 and x440 setup for establishing aims

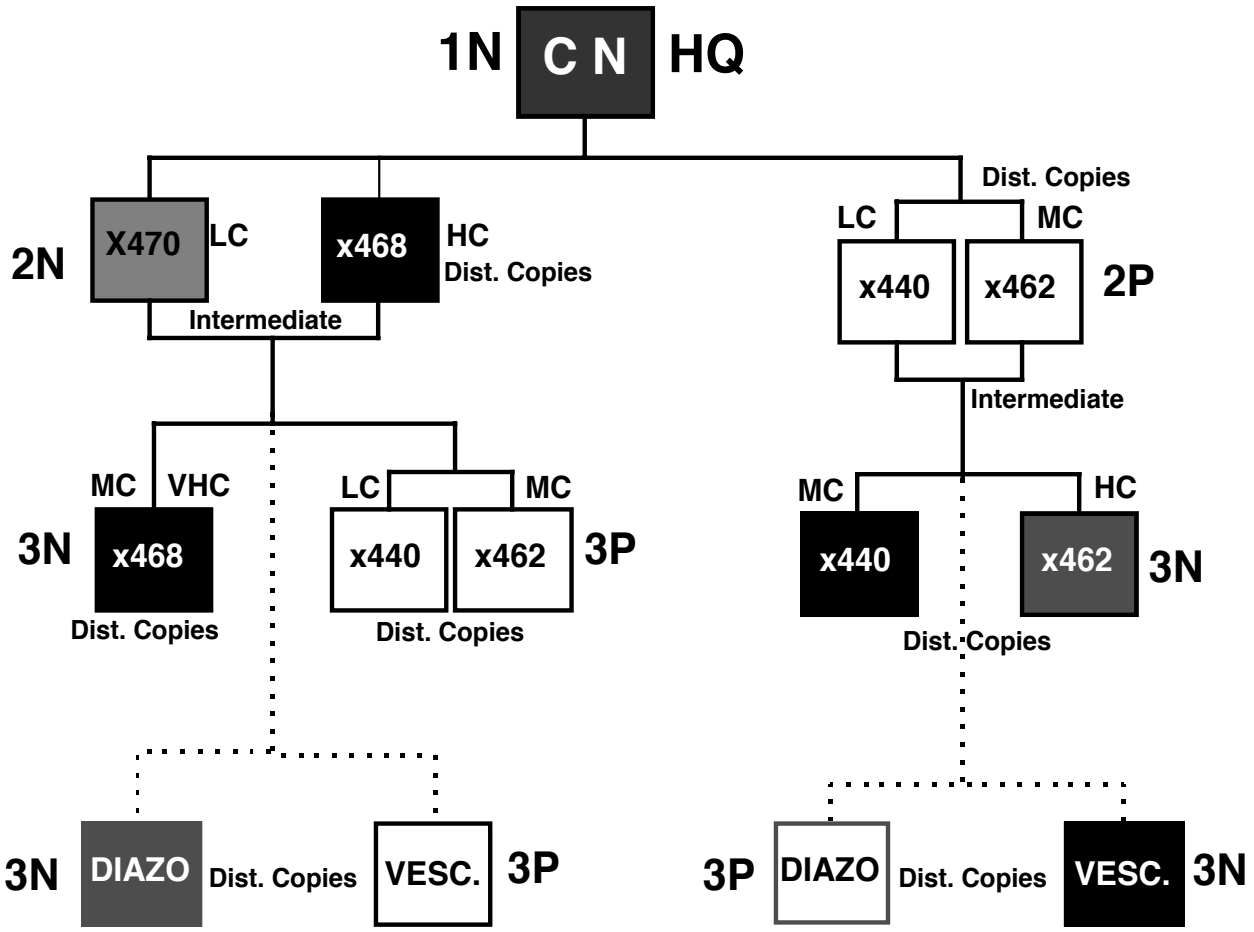


Figure 11: Duplication tree

Duplication tree

The above chart depicts how the various *Kodak* Duplicating Microfilms are used to produce the desired contrast and image polarity of distribution copies. As an example, 3N is showing 3rd generation, negative appearing distribution copies. (LC = low contrast, MC = medium contrast, HC= high contrast, VHC = very high contrast; Dist. = Distribution Copies; Vesc. = vesicular; CN = camera negative)

Process monitoring aids

A general working knowledge of the photographic process is extremely valuable for process monitoring.

The process monitoring aids listed in this document may be obtained through your local Kodak Representative or by ordering directly from:

Eastman Kodak Company
Business Imaging Systems
Department 454
Rochester, New York 14650
1-888-247-1234

EASTMAN KODAK COMPANY
Business Imaging Systems
Rochester, New York 14650
1-800-243-8811 or 716-722-9287

KODAK CANADA INC.
Toronto, Ontario M6M 1V3
1-800-465-6325

http://www.kodak.com/go/
businessimaging

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