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Emulsion Exposure

Light from exposure units can vary in both strength and in wavelength output. Exposure lamps come in a variety of types from fluorescent tubes to high output metal halide. All can vary widely in the wavelengths they emit as well as the amount of UV light they emit. Just because a lamp emits light does not mean it can expose the emulsion to it's maximum potential. Just as cars have varying degrees of horsepower and performance, so do exposing lamps.

During the exposure process light activates the photo sensitizer to cross link the emulsion's chemistry. Emulsions need a multi spectral output bulb with high wattage for optimum performance. The wavelengths of the light should spike between 380 and 420 nanometers, the wavelengths that interact best with the sensitizer to cause the screen to expose. Often the box the lamp comes in has a histogram of the wavelengths generated, if not ask for one from your supplier, or request the spectral wavelength output of the lamp you are using. See Fig 1.

Fig 1 – Multispectral Lamp output.

Fig 2 – Single Spectrum Lamp.

It should show multiple spikes if it is multi spectral, or it may only show one wavelength where it emits UV light. Multi-spectral bulbs interact more with the sensitizer producing better cross linking of the emulsion product. Single spectral bulbs may only activate a portion of the sensitizer to that wavelength while other components of the sensitizer receive no activation. Sensitizer is the diazo or SBQ component(s) of the emulsion.

The strength (wattage) of the exposure lamp needs to be strong enough to penetrate the entire emulsion film thickness for optimum cure as well. Weak fluorescent light systems and lower wattage single spectrum metal halide lamps simply do not have enough energy to crosslink the entire emulsion film completely. If you print plastisol you can still obtain a good screen with these systems but you will have difficulty making *strong* plastisol, waterbase, discharge, and thick film screens destined for automatic press production. An exposure system that can work for a manual printer with small print runs may produce inadequate screens for automatic press production and longer runs, the usual issue being dramatic increases in pin holes and stencil breakdown. Exposure systems with multi-spectral wavelength bulbs and a wattage of 3K or more will produce durable screens for plastisol, water base, discharge and high density printing.

Some notes on Automatic Presses

Automatic presses are expensive to operate when printing. They become much more expensive if they stop during production. They require more space in the warehouse, three people minimally to operate at full speed, a larger oven consuming more energy, and more consumables in emulsion, screens, tape and ink. To make the system profitable it should run as close to non-stop production as possible. Stopping to repair a weakly exposed screen can take several minutes. If you are printing 360 pieces per hour this can cost you six prints per minute of downtime or more. If you package and sell the shirt and print together and the downtime runs three minutes you can lose $128.00 in production billings plus the labor, rent and energy costs waiting for a screen to be repaired. If you are running a 10 color job the chances of this happening several times an hour increases if the screens are poorly exposed and can make or break a company. If you run newer servo drive automatics capable of 700 or more pieces per hour the losses are even more dramatic. Creating great non-stop production systems requires emulsions fine tuned for their purpose such as: Aquasol HV or Aquasol TS for waterbase, discharge or plastisol. Photocure PRO for sim process, SP-7500 and Photocure BLU for plastisol. Check Applications or Emulsion Guide to select the best emulsion for your needs.

Another factor affecting the quality of the exposure is lamp life. If a bulb has been used for over a year it is advisable to replace the bulb and save the old one for a back up. If you have been exposing screens using seconds you will be underexposing the screen after about six months of daily use shooting 10-20 screens per day. The more screens you expose per day the faster the lamp will lose its' UV capability. Use units instead of seconds if you have an integrator connected to your light source. If you only have a timer it is advisable to re-calibrate the times you use every three months by using an emulsion calculator or step test (described below) to adjust the times upward to compensate for the weaker light from an old bulb. Just because the lamp is bright doesn't mean it is producing the same UV light as it did the first time it was used. Older lamps may still be bright but have a yellow cast to the light and produce less UV than a newer lamp, which will have a bright bluish violet light.

Exposure Units and Ink Systems

Waterbase, Discharge, and Thick Film screens benefit from strong light sources. 3K to 7.5k multi-spectral bulbs create stronger screens. With water base or discharge screens the few microns of thickness covering the squeegee side of the mesh needs complete exposure to avoid delaminating or breaking down during automatic production. The higher the wattage multi spectral bulbs expose screens on the squeegee side better and result in screens that last farlonger during production with fewer breakdown stops for pinholes or delaminating. The Grand Canyon was created with water and demonstrates its' erosive power. The thin coating of emulsion over the squeegee side of the mesh is under attack by the squeegee as it moves abrasive water back and forth trying to soften and scrape the emulsion away. A weak exposure system simply cannot cure the squeegee side of the emulsion well. See Fig 3 for a graphic example of the amount of light reaching the squeegee side of the screen.

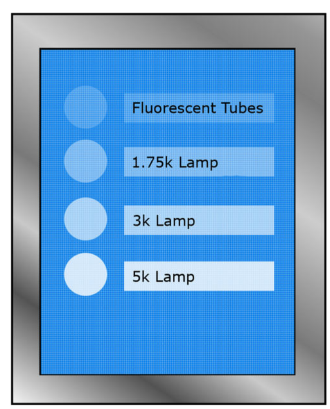

Figure 3
Light Strength

Proper Exposure of Emulsion

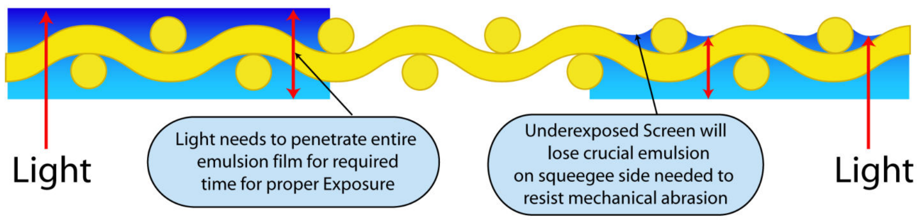

Fig. 4 Exposure

Exposing Emulsion and Thick Films

With High Density screens the Thick Film hinders exposure of the adhering fluid. The adhering emulsion needs good exposure to insure the Thick Film stays adhered to the screen. Commonly a weak exposure system will not expose the adhering emulsion no matter how much time it is exposed for resulting in de-lamination of the thick film, or will create a weak bond that will flex and delaminate during production.

If you have a weak exposure lamp there are 'work a rounds', but they often present a band aid solution requiring excessive labor, time and materials. Fine detailed block out and massive taping of the screen both consume supplies and labor expenses. If your light source is homemade, a fluorescent system with weak bulbs, a single spectral bulb, or an old bulb, any emulsion breakdown can be traced back to a weak light source. Post exposing may add strength to the screen if you use SBQ emulsions but the emulsion will never perform as well as a screen exposed to strong actinic light in the exposure process. See Fig 4: Exposure

Exposure Distance

The exposure distance from the light source plays an important part as well. Too close and the center of the screen will be overexposed while the corners may be underexposed due to light reflecting off the glass. For enclosed units the optimum distance has been established. For wall mount units with a free standing lamp, 40-52 inches is common. Too often we see operators load the wall mount with 4-6 screens while pulling the lamp back another 3-4 feet to get light on all screens while using the same or slightly longer exposure. This is OK as long the exposure time increases dramatically. Putting lines on the floor and then calibrating the different exposures needed for each line and mesh is recommended. An exposure with the light twice the distance away than normal will result in an exposure 4 times longer due to light's inverse square law. See Fig 5 Light's Inverse Square Law

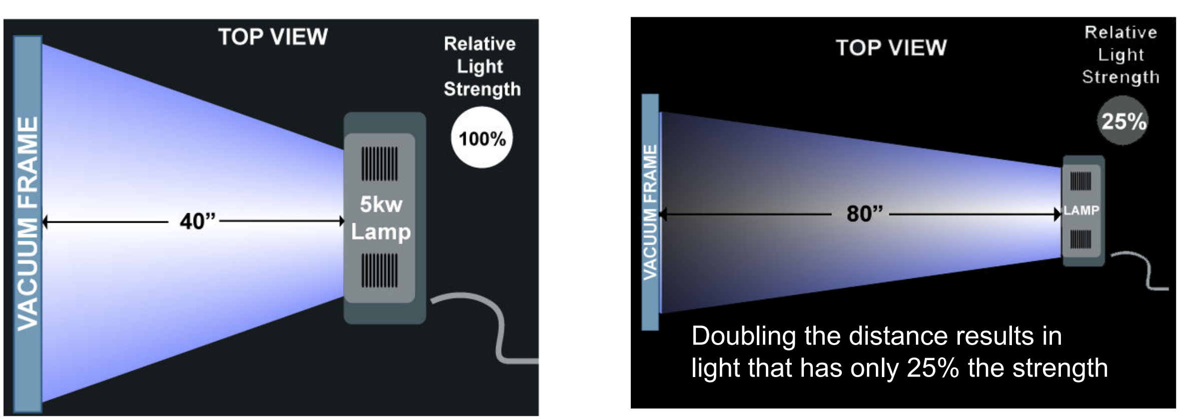

Figure 5: Light's Inverse Square Law

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Exposure Integrators

If the integrator is set to units it will measure the light units and no adjustment to times may be necessary, however the integrator may never turn off because the light amplitude reaching the sensor is too weak. At double the normal distance from the vacuum frame the light is also one fourth the strength. Optimum emulsion exposure takes place when the light source is in the 40-52” range since light strength and even illumination of the screen is the best. Fluorescent tubes proximity is usually built in to exposure unit and are placed much closer due to their lower wattage. Light in these systems tends to be chaotic, hitting the screen at all angles while a pin-point light source will exhibit more parallel rays with reflectors designed to prevent excessive light scatter.

Film Issues

While a strong light source can have production benefits, stronger screens, and better exposures the film used with strong light sources needs to have a high D-max. D-max refers to the black portion of the positive’s ability to block light. A 4.0 d-max is pure black on the film. You cannot see through the blackened image area. A good test is to output two 3” squares and place them overlapped on a light table. See Fig 5. If you see the overlapped area darker than the 3” squares your D-max is lower than optimum. If you hold the square up and can see through it as if it were dark sunglasses the D-max is unacceptable. Vellum is particularly difficult to get optimum D-max, although toner enhancers may help somewhat, they still fall well short of being able to shoot completely exposed screens and usually require under-exposure to avoid burn through which can prevent the print areas from washing out. (See Fig 6). The newer Epson 4880-11880 ink jets with Murakami’s Filmgate RIP achieves optimum D-max levels while providing image setting linearization capabilities to produce fine opaque halftones with accurate tonal ranges. Murakami offers an inexpensive imaging system as well as CTS devices for better D-max. See Process Tools, Epson Imagesetter, or Flex Jet on Murakami’s website for more info.

D-Max Test

Film Issues Continued

To compensate for weak film D-max, screen makers want to underexpose their screens to avoid ‘burn through’ where the film’s D-max is weak. You *cannot* achieve good production screens with this method. Waterbase and Discharge screens will fail much sooner on press, ***see fig 4*** for underexposed stencils. Plastisol screens will pinhole, water base and discharge screens will breakdown sooner, and dot gain or loss will affect 4/C process and sim process prints.

Too often the screen maker believes he can block out the entire bottom of the screen, post expose or use excessive tape over the entire screen to fix the problems created with underexposure. The screen only performs well when it is exposed *completely*. Underexposure uses extra labor to block out screens, causes pre-mature breakdown on press causing production downtime and loss of revenue. It also requires extra tape and labor to apply, extra labor to remove lots of tape after production, and tape residue that can hinder reclaiming efforts. This misconception of underexposing screens is very costly to profits. If you wipe the inside of a screen being developed with a white cloth and you see emulsion color, chances are you are washing away expensive emulsion needed for optimum press production.

A side note for water base and discharge: Taping off the entire bottom of the screen traps the moisture on the print side of the emulsion causing the screen to breakdown sooner.

Lastly an underexposed screen is harder to reclaim. An underexposed screen has unlinked sensitizer that can be flashed chemically and cross linked with mineral spirits, screen openers, or screen cleaners. In some cases the mesh is lost since the emulsion is flashed to an un-reclaimable state. A completely exposed screen does not suffer this chemical flashing issue, all sensitizer is cross linked and the emulsion remover can break these bonds easily versus a chemically flashed cross link that may be permanent.

Determining Proper Exposure

Exposure calculators determine a good starting point for exposures. The basic idea is to double the recommended time for the emulsion and exposure unit you are using, develop screen with a fan spray pressure washer and select the panel in the exposure calculator that has exposed completely with good resolution properties. (See Murakami Technical Data Sheet PDF’s available at www.murakamiscreen.com for starting exposure times for the Murakami emulsion you are using.)

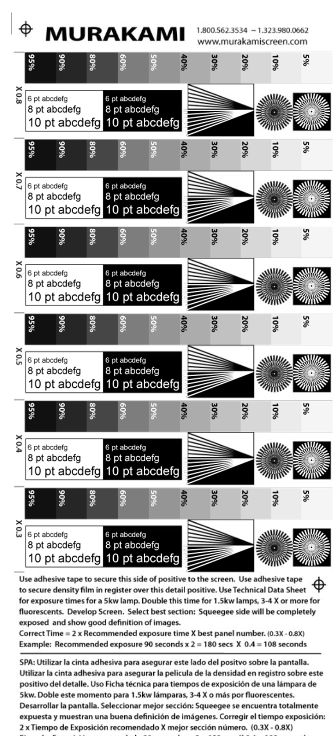

Figure 6
Murakami Exposure Calculator (Textile)

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Exposure Calculator Directions:

- Set timer or units to double the recommended time listed on the technical data sheet for your Murakami emulsion for 5kw lamps. For 1.75kw triple the time and for 4x-10x for fluorescents. It may take several tests with fluorescents to find a doubled time that exposes the emulsion well in one of the panels.
- Place detail film on screen with test images to print right reading.
- Tape density film in register over the test image film.
- Expose screen at double, or more depending on exposure unit.
- Wet both sides of screen, wait 30-60 seconds to soften emulsion.
- Wash out with a pressure washer set to fan spray at a distance of 18” spraying only the print side of the screen.

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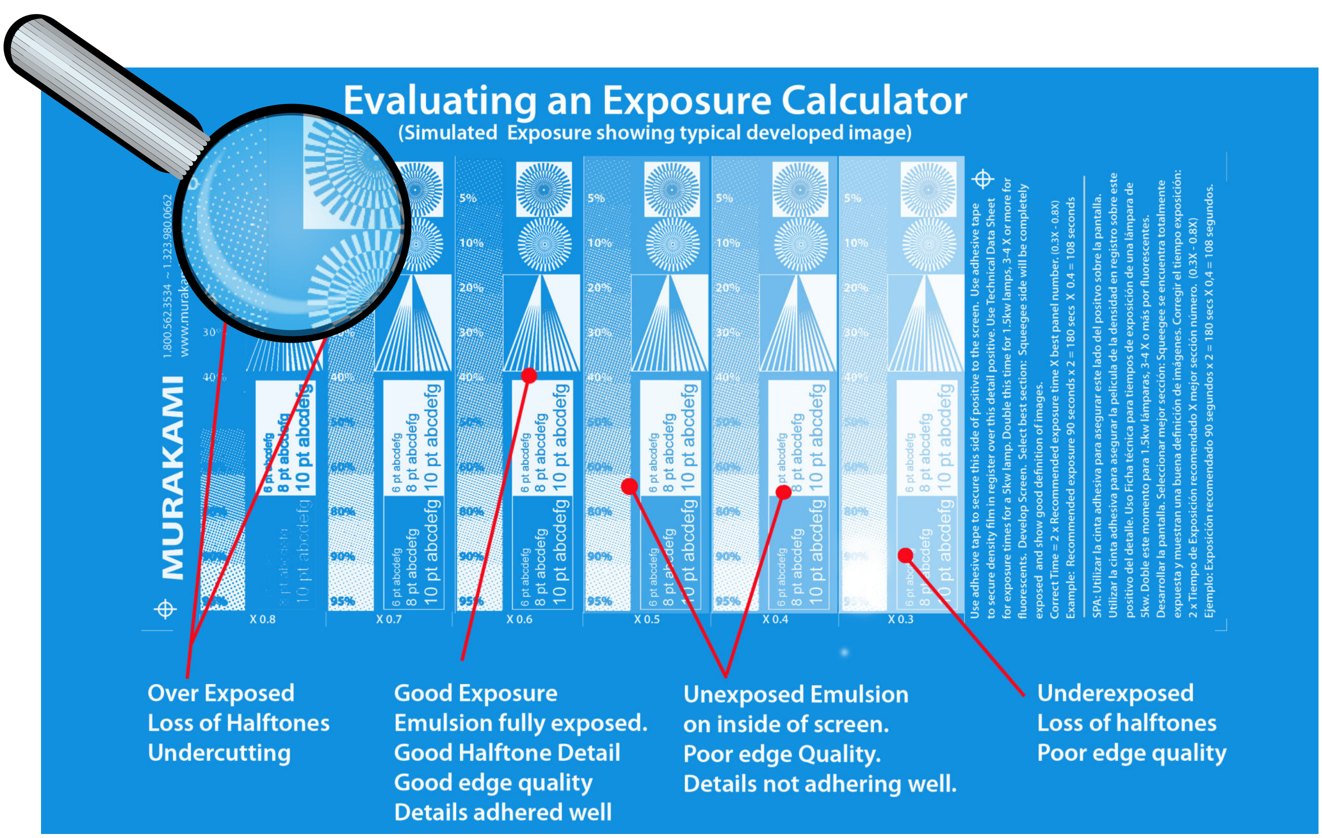
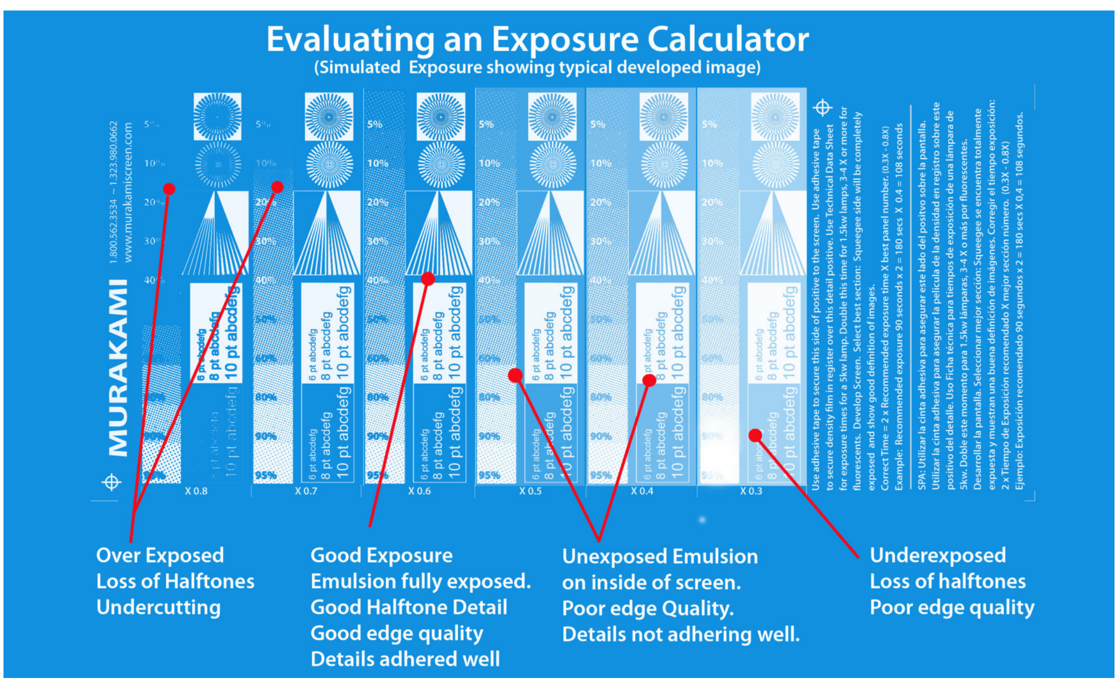
Leave screen wet for the first part of the evaluation to check for undeveloped emulsion on the squeegee side of the emulsion and select best panel that has no unexposed emulsion (emulsion should not feel slimy or exhibit any melting.)

For evaluating halftones and details dry the screen completely and inspect with a loupe or magnifying glass.



Once the image is washed out you will see the emulsion color changing from light to dark within the series of panels. The panel with the best exposure will have the same color emulsion when viewed from the bottom side as the emulsion where no film was placed. On the squeegee side find the panel that has no melted emulsion or slime and when the screen is dried and viewed under a magnifying loupe shows good halftones with no undercutting, sharp edges, and sharp points on both converging line images, both positive and negative. See figure 6 The right colored panel and with no slime on the inside and good halftones may be the same panel or right next to each other, choose one.

Underneath the best panel will be a multiplier number such as 0.5X. Multiply this number times the time/units you used to shoot the 2X normal exposure calculator test. If you are exposing on a 5kw with a fairly new multi-spectral lamp the multiplied result should be close to the recommended exposure time on the Technical Data Sheets. (We use a 5kw multi spectral bulb for our tests.) If the entire inside of the screen is slimy and not cured go back and start over but this time triple or quadruple the recommended exposure time. This will often be the case if you are using weak fluorescents, low wattage bulbs, or have an old lamp in your exposure system. Once you have a well exposed panel, regardless of the multiplier number at the bottom, do the math and begin a chart listing mesh, color of mesh, mesh count, emulsion type, and the time you just determined using the exposure calculator. See PDF download for a suggested form that you can post in your screen room.



Example
Recommended exposure from Murakami Technical Data Sheet: 120 seconds
2X recommended exposure: 240 seconds
Exposing on a 5kw multi spectral exposing unit showed the best panel to be the X 0.6 panel.
X 0.6 times 240 = 144 seconds, convert back to units if you have an integrator.

Evaluating an Exposure Calculator Cont.

If your best panel multiplier is less than 0.5x it just means the lamp you are using has more output than our lamp.. If the multiplier is above 0.5x your light source is weaker than ours, just do the math to get your exposure time as shown above.

It may take some experimenting if you are not shooting on a 5kw lamp. Typically a 1.5-2k lamp will multiply the suggested times on the TDS sheets by 3x to 4x, it all depends on the spectral output and amplitude. If all panels are underexposed keep increasing time until overexposure is achieved in the X 0.8 panel. The goal is to adjust times until you get both an overexposed panel in the X 0.8 panel, and under exposure in the X 0.3 panel.

Units vs Seconds

Unist are always the preferred method of exposure, however for a first time exposure calculation using seconds is easier. Some integrators convert seconds back to units, or you may have to measure how many units it takes to reach your target exposure.

In the example above 144 seconds was the proper exposure. To convert this to units may be automatic on your integrator, if not simply change the integrator to the ‘units’ measurement, set a higher number than you would normally use so you can watch the units count down or up, (depends on your integrator). With a watch count off 144 seconds and note the amount of units on the display when you reach 144 seconds. Use this ‘unit’ number for 144 seconds, or whatever your best panel time was.) If your integrator subtracts units as it goes note the number at 144 seconds and subtract from the number you set your unit display to. You may be able to set your integrator to have 1 second equal one unit. After about six months measure how long 144 units has become. In most cases your lamp will stay on longer than 144 seconds. The integrator is just doing its’ job and measuring the amount of light, not the amount of time. The longer time just indicates the bulb is aging.

Bulbs: Original Manufacturer bulbs are recommended, they simply last longer and have the right spectral output. Bulbs are finicky. They can strike, (light up) day after day, or they can suddenly not light up at all after only a few strikes. Bulbs are very delicate and subject to malfunction if you do not install them properly or use non OEM bulbs. Always use the gloves provided and wipe down the bulb after it is seated with the alcohol swab provided to remove grease that can cause the bulb to explode or fail pre-maturely. **ALWAYS DISCONNECT THE POWER SOURCE FROM THE EXPOSURE UNIT BEFORE SERVICING THE LAMP OR OPENING THE ACCESS AREA.**

The precise exposure time can be fine tuned further. The following method is a home made step test that can be used if an exposure calculator is not available, or it can be used to fine tune the time derived from the exposure calculator method described above, first: Fine tuning an exposure from a calculator derived time.

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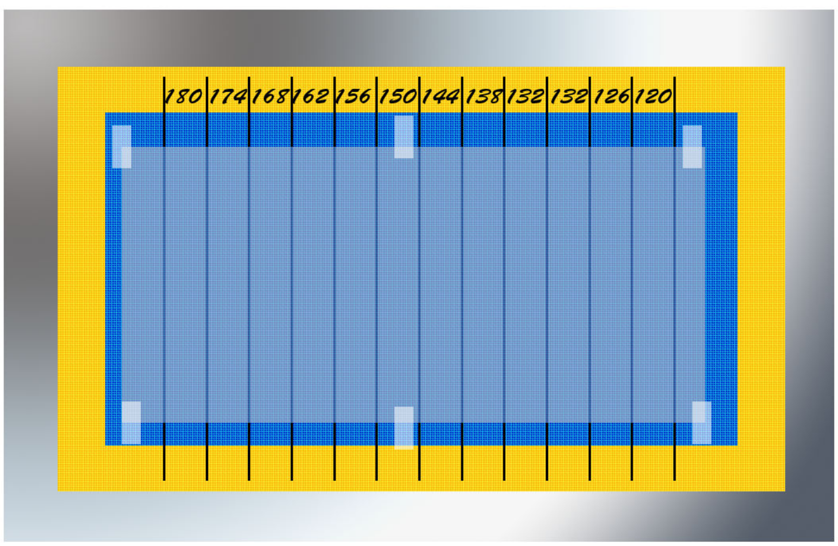
Fine tuning Exposure Times:

Output a 12” by 15” piece of film with a 50% halftone at the lines per inch and angle you use in production using the same mesh counts as your test above. 280 – 305 is best for the halftone test. Use a 2-4 pt line at 50% at 22 degrees for lower mesh counts.

Some common halftone settings:
2 to 4 pt line at 22 degrees at 50% (86, 110, 125, 165, 200 mesh)
45 line at 20 degrees at 50% (200, 230, 280, 305 mesh)
55 line at 60, 7.5, or 22.5 degrees at 50% (280, 305, 350, 380 mesh)
65 line at 7.5, 22.5, or 60 degrees at 50% (305, 350, 380 mesh)

These are available as PDF downloads for outputting on your image setter. You should use your rip and imagesetter for proper evaluation of your system.

Step Test



Tape the halftone positive to the screen. Along the edges of the film place a mark on the screen every 1 to 1.5 inches ten times starting at the edge of the positive along the long side of the film until you havea 12 panel step test Repeat this on the opposite side of the screen. These will serve as line up marks to block out areas of the emulsion we want to prevent from exposing.

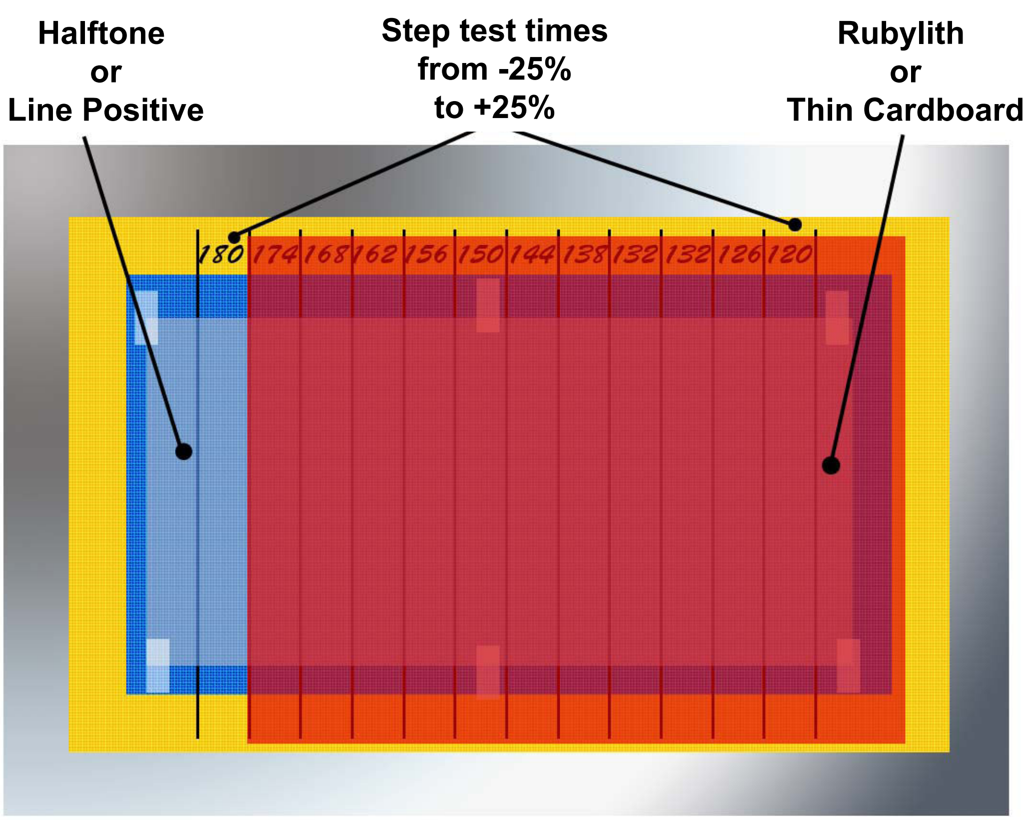
Now the math: If the calculator test above gave a proper exposure time of 144 seconds we can now determine if a little less or more light is better. The goal is to get multiple exposures between –25% and +25% of the exposure calculator time in increments to fine tune the exposure.

Step Test Continued

Example:
Derived Calculator Time = 144 seconds
25% X 144 seconds = 36 seconds
So –36 seconds to +36 seconds = 72 seconds
72 seconds divided by 12 panels = 6 seconds, this will become our step time. 6 seconds of extra light per panel on a screen that starts 25% below the calculator derived time.

If we expose the entire screen for 108 seconds (25% less than derived exposure calculator time) then begin our step test in 6 second increments at the first panel and end the 6 second exposures on the next to the last panel we will have the following ten exposure times:

180, 174, 168, 162, 156, 150, 144, 138, 132, 126, 120, 114 seconds. Write these times with a marker on the screen in their matching panel. The first panel will be a 180 second exposure, the second 174 seconds and so on.



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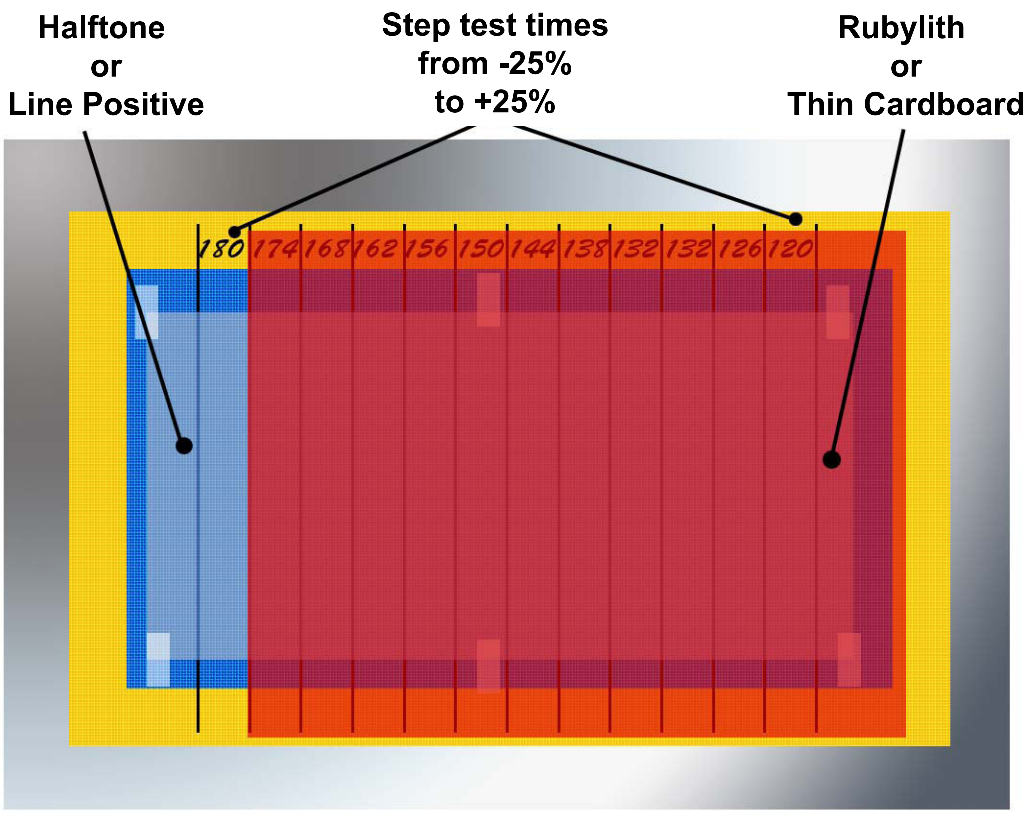
Step Test Continued

- Expose the screen with the 50% halftone or line film for 108 seconds.
- Place a large piece of rubylith, or a thin piece of cardboard on the second line leaving the 180 second panel unblocked for the first exposure and tape it down securely.
- Expose for six seconds. Move ruby or cardboard down to the next line for the 174 second exposure and expose for another 6 seconds.
- Repeat moving the block out media and expose for six seconds on each panel until you have exposed all twelve panels with 6 seconds of light.



Soak with water and develop with a pressure washer set to fan spray at 18" from screen. After development examine the panels on the inside of the screen. The best panel will exhibit no slime on the squeegee side of the screen. When the screen is dried and viewed under a 10X – 50X loupe or microscope the area where the dots barely touch will be sharp points and not exhibit undercutting. You may have several panels that look relatively the same which shows the latitude quality of the emulsion. Dual Cures will have a wider exposure latitude than SBQ due to the much shorter exposure times of SBQ. This test helps dial in the correct exposure to produce accurate halftones.

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Using the step test as an Emulsion Calculator

The only difference with this method is using longer exposure times for the panels and eliminating a pre-exposure of the screen.

Example:
Recommended Time from Technical Data Sheet =120 seconds.
2X Recommended Time = 240 seconds
240 seconds divided by 12 panels = 20 seconds per panel.

On the screen your panels will be marked as follows for a twelve panel test.

240, 220, 200, 180, 160, 140, 120, 100, 80, 60, 40, 20

Using rubylith, amberlith, or cardboard to block out the unexposed areas. Start at the first mark and expose for 24 seconds on each panel.

You can then use the previously described fine tuning method to refine the exposure.

Summary

- Strong multi spectral lamps produce stronger screens that perform better on automatics and for preparing screens for water base and discharge printing.
- Emulsion needs complete exposure to perform well.
- Through the use of calculators and step tests you can fine tune complete exposure of your emulsion.
- Under exposing screens increases costs in labor, supplies, and press stoppage.
- Using a Murakami Emulsion tailored for the ink you use increases screen performance when properly exposed.
- When your press stops, you lose money.

Murakami strives for winning performance on press producing the highest quality emulsion and mesh available. Feel free to contact us if you have questions. We will be happy to walk you through any of the methods described here.

Murakami Emulsions

Murakami Exposure Units

Contact Murakami Screen