Consistent Contacts
with
IMPROVED CONTROL

Ernest Ohlig*

ABSTRACT:

The demand for quality reproductions is rising, cost control and automation are of ever increasing importance. This brings about the need for tighter control, accuracy and repeatability of exposures. Such control involves several parameters that are part of this paper: vacuum, intensity and evenness of illumination, and resolution of reproduction.

INTRODUCTION:

Vacuum frames are the most commonly used means of achieving close contact between original and sensitized material. Incomplete vacuum draw may leave pockets of air that may produce distortion of the image. Excessive vacuum may cause pressure or Newton rings.

Light Intensity must meet the exposure requirements. The proper energy level in the "right" spectral range and the exposure time need to be established and maintained consistently and repeatably. Measurement and light integration are part of the subject matter, spectral match with the material another.

Evenness of illumination over the total exposure area may be of importance. The measurement of this parameter is most difficult and is discussed in detail.

Resolution, the ability to reproduce fine detail, is of concern in some applications. Other details discussed, such as light intensity, spectrum, evenness of illumination, and latitude of exposure all help to obtain the optimum resolution from the specific sensitized material used.

VACUUM:

Contact exposures depend on close contact between the original and the photosensitive surface to be exposed. To accomplish such contact vacuum is used rather than pressure for several reasons: 1. the pressure needed must be distributed evenly over the total surface to be effective; 2. there must not be any voids or air pockets; 3. it must be accomplished with glass or transparent material on the side where the illumination originates.

Some vacuum systems feature gauges. Atmospheric pressure in Standard Air at sea level is 760 mm, 29.92". That equates to a pressure of 1 kg per cm^2, 14.7 pounds per square inch. To visualise such pressure I attach illustration #1.

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VACUUM - PRESSURE					
Inches of Mercury	mm of Mercury	$\frac{lb}{inch^2}$	$\frac{kg}{cm^2}$	total lb on 30"x40"	total kg on 75x100cm
29.92	760	14.7	1.03	17640	7725
28	711	13.8	.97	16560	7275
26	660	12.8	.90	15360	6750
24	610	11.8	.83	14160	6225
22	559	10.8	.76	12960	5700
20	508	9.8	.69	11760	5175
18	457	8.8	.62	10560	4650
16	406	7.9	.56	9480	4200
14	356	6.9	.49	8280	3675
12	305	5.9	.41	7080	3075
10	254	4.9	.34	5880	2550

Illustration #1

As you can see, the pressure exerted to flatten the material in perfect contact is quite substantial. It also shows that the difference between some pressure levels is not very drastic. Yet, there are a lot of operators who insist on a specific high level of pressure/vacuum to accomplish contact. Will a higher pressure really yield better contact? Not necessarily we find. The reason is air trapping.

Illustration #2 depicts the basic setup used for contacting. The light penetrates through the glass, the original and any mask or overlay that may be used, and finally exposes the sensitized material.

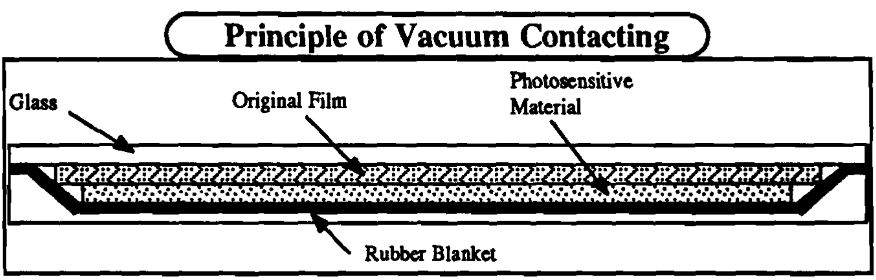


Illustration #2

It is also common to see the exposure made through a flexible transparent film instead of glass. In this case the bottom part, where the blanket is shown in #3, is a solid back, usually with holes to facilitate the vacuum draw (open face frame). The very great pressure of the air is equal from both sides. This is the reason glass or solid base will not break or bend under the load.

When vacuum draws the blanket, it will pull the center first, but also the sides. With the sides or corners being closer to the evacuation valve, the air resistance is lower and consequently the vacuum/pressure higher, once the material is close to the glass or hard surface. Even in open face frames with vacuum ports over the hole area, the exhaust still has to go around the edge of film and material. The outer area now seals first to a point that will no longer allow the air trapped in the center to escape. It binds the materials.

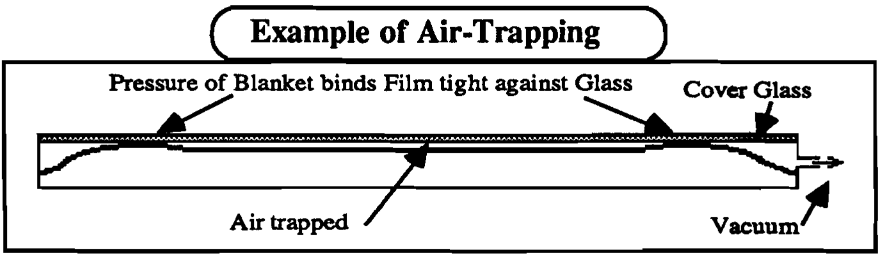


Illustration #3

The typical case of air trapping is shown in #3. In most cases the air pockets are very small, yet equally as damaging. It can take a very long time to evacuate all the air once the binding has occurred. This time is longer under high vacuum pressure rather than lower, because the seal becomes tighter.

There are several remedies to reduce trapped air difficulties. The first is the use of matte surface film that will allow the air to escape. In many instances this is unacceptable. Second is a the method used on many European frames, a two stage vacuum system. The first stage brings the vacuum to a predetermined low level of evacuation. It then pauses to assure that the air trapped in the center can escape and all material is evenly pressed against the glass. Then the higher vacuum pressure is applied. This is time consuming but effective.

Another way is to reduce the vacuum through means of a preset relief valve. It is very common here in the U.S. to work towards a pressure of 26". There are certain types of material that require such high a vacuum, but that is rare. It has just become so common that operators accept it as a rule, which it is not. It is far more important to go for elimination of air pockets and consistent pressure with every exposure. Therefore I recommend to try to back off to a lower pressure, even as low as 18", and see if your material exposes well. If it does, you have just speeded up the vacuum draw time, eliminated air traps as well as pressure or Newton rings. Certainly worth a try!

The most successful recent introduction in the U.S. appears to be the Fast Draw® system. It tries to copy the motion that would be used by most operators laying down a film flat, without distortion. The hand movement goes from the center, generally the middle of the pin bar, outward towards the corners. It appears the best way to avoid movement out of register. See illustration #4.

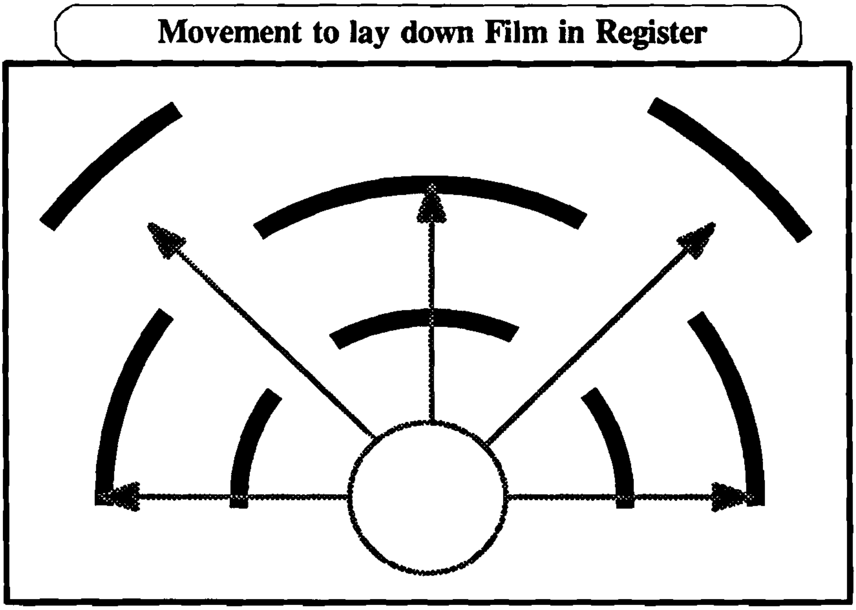


Illustration #4

The Fast Draw® lifts up the blanket gently in the center at the front first, then moves towards the outside and the corners while the vacuum is drawn. This has greatly speeded up production time while eliminating the incidents of air trapping.

The blanket or transparent cover is of great importance. It must have the right flex and pattern to meet the requirements of the application. With plates, PC boards or other hard sensitized materials the blanket often has a coarse pattern to allow free flow of air for quicker exhaust. Such patterns can leave marks on films and can be the cause of pressure rings. Softer and finer patterns are used in those applications.

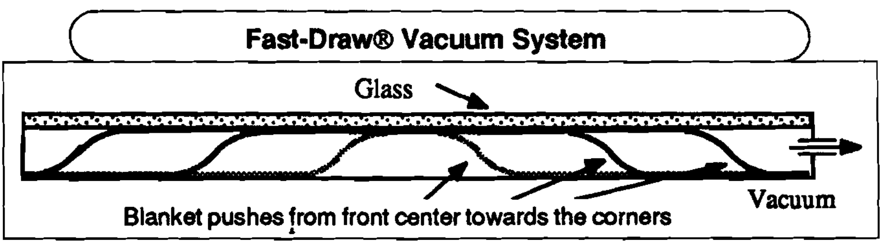


Illustration #5

Ultra Violet exposure illumination, UV, has the great power of aging rubber and plastic materials, robbing it of the pliability necessary for good contact. Check all blankets periodically and replace them with new ones for better results. It is a small investment that soon pays for itself in better reproduction quality.

The most common problem arising out of incomplete contact is "undercutting," a similar effect utilized when making "spreads and chokes." To check this it is necessary to expose the complete exposure area since the air pockets can arise anywhere. Often, however, a pattern persists.

The first test is a visual one, looking at the frame with the exposure light or a flashlight at 45° (Robert F. Reed, GATF) on a white card. Make sure the necessary eye and skin protection is used when UV lights are the source. By inserting a screen tint, a moiré pattern will indicate areas of inconsistency and air pockets.

This is a relatively coarse test that should be followed by actual exposure of screen tints. Marv Hallam, consultant to the Graphic Arts, suggests a 5% or smaller dot screen. The exposed and processed copy is placed on a light table and, by looking at it from an angle, will quickly show if and where areas of smaller dot size appear, or where the dots become invisible at all.

Should it prove that the dots are all reproduced, it can be trusted that the vacuum is sufficient to do the job. Naturally such a test must be made under the worst condition that should include the maximum number of overlays.

It is important that inconsistencies are not confused with hot spots of overexposure that are subject of discussion in one of the following chapters. Hot spots in illumination patterns will remain in the same position and retain identical shape, unless the light or lamp are changed or modified. Spotting of incomplete vacuum draw may occur in the same position but generally changes shape and location. See further information under EVENNESS in this paper.

The size of the light source, the collimation and the color of the light, or UV spectral emission, are major factors in the effect that air pockets or incomplete vacuum may have. It is one of the basic design parameters of OLITE lights to produce a high degree of light collimation to help cover up some of the flaws caused by trapped air. Such air traps cannot be avoided altogether, considering that even tiny dirt particles can be the cause. Unless "clean rooms" are in use, we will have to cope with the problem.

One last word on Newton rings. The collimation of OLITE lights does help in the considerable improvement in resolution, even with vacuum or other problems. Even with some space separation, E to E, hard dots may be reproduced. This has caused some difficulties in the identification of the problems if the operator was used only to the conventional, non-collimated UV lights utilizing large, round reflectors. Those lights soften and loose dots with slight spacing.

Collimated light does, however, show up Newton rings much more quickly (proof of the high degree of collimation). Reduction in vacuum pressure solves the difficulties with pressure rings in most cases. If it is not possible to cut vacuum pressure, it has always helped me to rub the glass with some talcum or baby powder before inserting the film. Even rubbed off completely, as we think, enough of the now invisible little grains seem to adhere to the glass to allow some air separation that helps the trapped air escape.

* Fast Draw® is a registered trademark of Teaneck Graphics Corp.

LIGHT INTENSITY:

Light Intensity must be matched to the requirements of the sensitized material. High sensitivity is used in darkrooms with low wattage point lights. Lower sensitivity materials are handled in room light conditions and exposed with bright, high wattage lights, high in violet and UV content.

The trend has been to abandon the darkroom for many reasons, not the least of which is health. It is far more beneficial to the operator to work in well lit and ventilated surroundings rather than having to switch from light to dark repeatedly, or worse still, spending all day in a room void of blue light and UV.

There is no question that a good amount of exposure to UV "A" is of great benefit to health, building vitamin D and natural body defenses against sickness. In effect, humans, just as most living creatures, need UV for growth, health and even survival. It is overexposure of skin and eyes we have to be careful of.

This paper concentrates on exposures using UV illumination. The basic principles can be transferred to other light sources as well.

The purpose of an exposure is to interreact with silverbased or photopolymer emulsions, photoresists or electrostatic materials. Each of these materials poses different challenges that should be resolved by the user in cooperation with the manufacturer of the sensitized material. OLEC is willing to make equipment available for basic testing.

The function of exposure of resists, coatings on plates, PC boards and screens is often misunderstood. UV and Violet rays harden the coating through photocross-linking or photopolymerization on negative working materials. In positive working resists, the area exposed to light or UV becomes soft and more soluble. In the single exposure positive resist, photogeneration produces an acid from nonacidic precursers that softens the exposed areas. In two-exposure positive resists a photoinhibitor precurser is added to a usually negative working system. The initial imagewise exposure unmasks the inhibitor and a second blanket exposure cross-links the resist where the inhibitor was not produced. (F.J. Weigert and S. Proskow, 1987)

To establish the base exposure, the easiest, most common and reliable tool is the continuous tone step scale, combined with some dot or line patterns. These are available in different formats and for different applications. Test exposures are made using a range of exposure times. The dot or lines are inspected first with the glass and then the exposure checked on the step scale. Depending on the result of the dot or line reproduction the most desirable step exposure is determined, not the other way around. From then it is important that the same step exposure value is maintained.

More precise methods to establish accurate exposure times required for plates are described in a detailed paper by C.S. Krikelis and M.P. Dunkle of E.I. duPont and a further paper by J. Frank Yule, particularly in regard to the Murray-Davies-Yule Equation.

It is very important that ALL tests using a continuous tone step scale be made in the center of the area to be exposed, never in the corner.

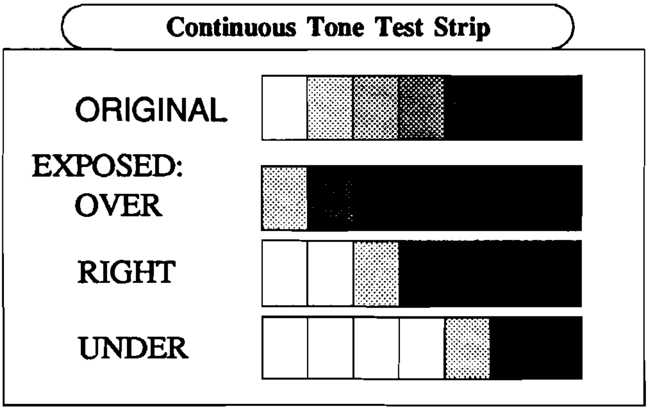


Illustration #6

Continuous tone film has a specific and predetermined density when viewed from a perpendicular direction. From an angle this density increases (see in the chapter on measuring evenness in this Paper) to a point that the density is almost an absolute black. Any testing device that changes its character under varying conditions must be used with care. Continuous tone test strips are a reliable and accepted test for repeatability, not absolute value.

Over and underexposure can have different effects, depending on the material. Overexposure can cause excessive undercutting and can destroy fine detail. Underexposure or inadequate light intensity may effect incomplete penetration that may show itself in insufficient density on film or similar material. On resists it may be the cause of poor bonding to the substrate or incomplete curing, which will show during washoff or processing.

Spectral sensitivity should match spectral radiation of the exposure light source. Better still, a light should be selected to match the sensitivity of the material to be used. Most commonly used sensitized materials fall into the following ranges: 350/375, 375/400, 400/425nm, and materials sensitive to longer wavelengths, commonly used in darkrooms under safelights.

Lamps can have high peaks and valleys, others feature more of a continuum as is shown in illustration #7, lamp #1 and lamp #2 respectively. These are lower pressure lamps that are carefully designed to radiate in specific spectral ranges only. High pressure short-arc and water-cooled lamps are not doped with halides and develop a continuum in other colors that diverts energy for low efficacy.

It is a very complex matter to understand in detail the way light rays and sensitized molecules interreact. Diazo and Photopolymers of different molecular structure feature distinctly different personalities. Application tests are the best way to establish suitability of a light or UV source. Theoretically, matching the sensitivity curves published in literature should produce perfect results in speed of exposure as well as resolution. Yet our tests showed a number of surprises.

Spectral radiation outside of the true exposure sensitivity can act as speed inhibitor. Some tests lamps produced the highest speed but showed less resolution. Moving the spectrum into shorter wavelengths lengthened exposure times yet rendered greater resolution capacity. Some limited or expanded exposure latitude. All of these parameters are important.

The function and design of metal halide lamps is discussed in other papers of this author, presented at TAGA and PCMI. All lamps are radiators of UV and/or visible energy. All generate a certain amount of heat, IR. The manufacturers and designers of gas-discharge lamps, such as the metal halide used in most of our applications, try to convert the input electrical energy into the highest amount of radiant output, reducing energy losses to a minimum.

Efficacy is the idiom used to describe energy efficiency in terms of application. The main design parameter is to convert as much of the available electrical power into energy radiation of the "right" spectral mix. Right in this case translates into the most desirable spectral output for specific applications. New lamp designs, such as the Olite L 1250M have gone a long way towards this goal.

Measuring the actinic energy/light output with a lightmeter is not meaningful unless such a measurement is limited in sensitivity to the spectral response of the film or sensitized material. The exception are measurements with sophisticated measuring devices, such as radiometers, that display energy radiation of a predetermined spectral range only.

Illustrations #8 + 9 show graphs demonstrating *efficacy*. The film sensitivity chosen is very broad. Narrower sensitivity segments are common in different materials and will produce different results. The spectral emission of the two lamps shown in illustration #7 are used as the base.

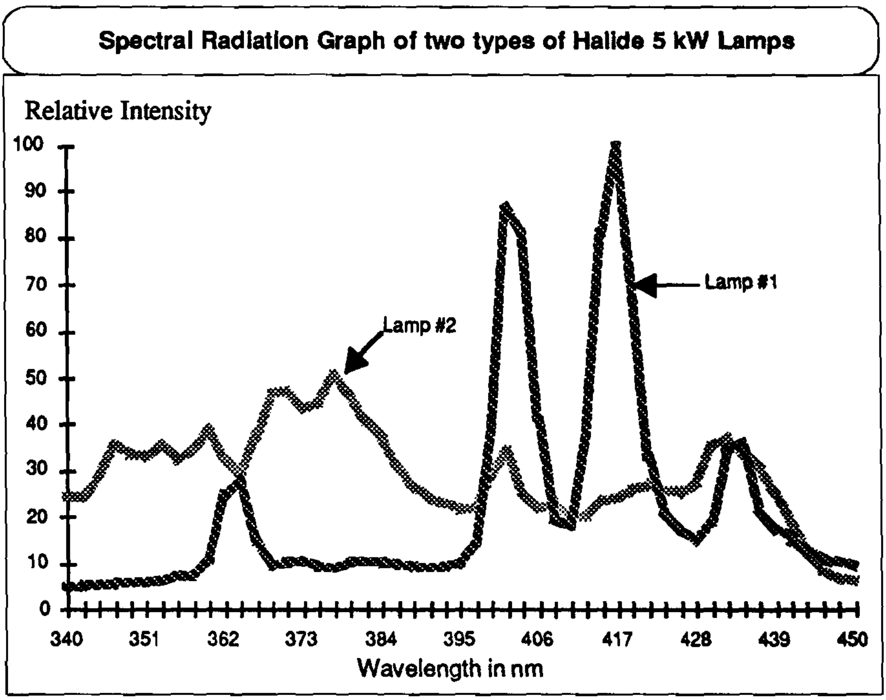
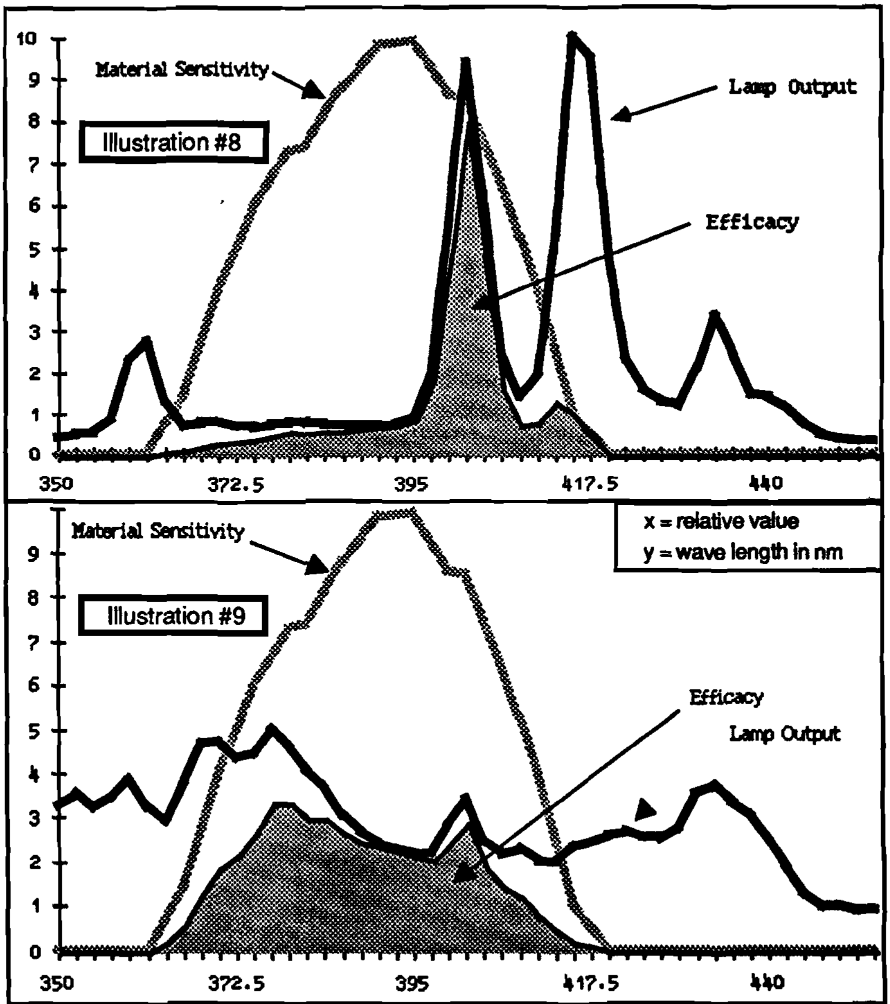


Illustration #7



Definition of Efficacy

Illustration #8 + 9

LIGHT INTEGRATION:

Once the basic exposure, time or energy, is established it is important that the consistency of exposure is maintained. Lights can vary in intensity of radiation. The reason is not just the constant fluctuation of incoming line voltage but, in case of gas discharge lamps, the operating temperature. This temperature varies through ambient, the amount of use and the length of exposures.

Olec has developed a servo-cooling system for mercury halide lights that reduces the change in intensity and shift in spectral output substantially. It also greatly enhances lamp life. Even with temperature control there is still enough of a variable to benefit from closer monitoring of effective output.

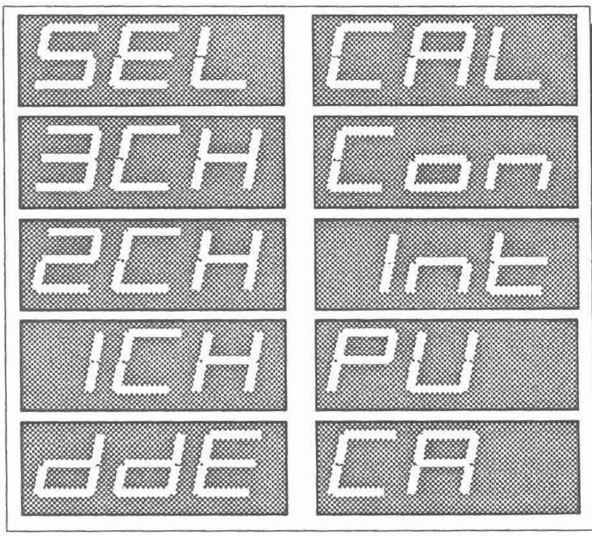
All applications that demand accurate exposures call for Light Integrators.

Light integrators of analog design have been around for a long time. They used to be very expensive, at times unreliable, and required periodic service such as cleaning and replacement of the sensor, a photosensitive vacuum or photomultiplier tube. Modern digital devices have little in common with the older equipment, other than the basic principle. That principle is to accumulate energy until a predetermined level is reached.

New light integrators still use analog sensors, nearly all of which are of the solid state silicon type. The analog signal of these photo-electric cells is converted into digital pulses, which are counted by micro-processing devices.

Microprocessing has added almost limitless possibilities for programming of functions, such as memories, remote switching of power levels, remote selection of different lights, auto-step to the next exposure value, vacuum pump or shutter delay control, remote control of motorized filters, compensation or override of an individual or a combined series of exposures in log density steps or percentages, compensation for enlargement or reduction on cameras and many others, all found on the Olec line of Olix integrators. (Illustration #10)

This all may sound confusing and exorbitant if the job just calls for repeatable exposures, day in day out. Simple units are available for such applications. Considering that a programmable unit may need programming and calibration just once, that it will remember many different functions with just a simple push of a button to eliminate individual setup time, reducing waste of time and material and considering that such an instrument is available for under $1,000, it stands out as a wise investment.



LED Display showing the variety of programming choices of a Modern Light Integrator

(OLIX AI 970/971/980)

Select, 3-2 or 1 Channel, Dry-Dot-Etching, Electronic Calibration, Continuous/Intermittent Pump/Shutter Delay, Camera Operation.

Illustration #10

Photocell filtration is of great importance. It is assumed that an accurate match with material sensitivity is of paramount importance. Theoretically, and ignoring many influences other than the laboratory test on wavelength response, this may be true. In practice it is not rational.

Sensitized materials change their characteristics more often than we would like to hear because of advances in technology, chemistry or production techniques. Such changes are not publicized by the manufacturer. Different materials feature different spectral response. It would therefore be necessary to have specific photocells for every type of material exposed.

To develop filtration that precisely follows a sensitivity curve would be very expensive, with a single photocell alone costing more than the complete light integrator. That would still not take into consideration the gamma curve and reciprocity failure. To accomodate those additional factors involves costly and complex software. One must therefore look at the requirements in a realistic way.

Filtration of the light entering the photocell is nevertheless of great importance and has prompted research at Olec. We established that with the great variety of filters used on different integrators, the most serious shortcoming in all was the inability to eliminate the reading of IR radiation that invariably causes errors. After a series of tests we developed a narrow-band-pass filter that limits sensitivity to the UV range from 340 to 400nm. It filters out all IR. Its application is with materials sensitive in that particular spectral range of the UV.

Light integration should be used in ALL applications where precise exposure timing is a requirement. Light integration depends on accurate data input, the photocell. Well designed modern digital circuitry is steady and not subject to variations or fluctuations. If inconsistencies do arise, they can invariably be traced to the analog input at the photocell. The input into the digital counting and calculating circuitry of the integrator is generated by the photosensor and the analog-to-digital converter.

The photocell should be mounted within the area of the prime cone of emission or directly reflected rays from the UV source, the lamp. It should not be exposed to or affected by possible reflection from side-walls, curtains, copy or other, and should not be mounted in the direct area of extraneous ambient light.

Mounting the photocell on the frame is the most misunderstood practice and most troublesome in service calls. For this reason we reiterate: users feel that a photocell *must* be mounted at the side of the vacuum frame. This is unwise and can lead to erroneous readings.

A photocell mounted on the edge of the frame is exposed to all kinds of difficulties and potential errors, variations in light intensity. The most common is a reflective curtain that may hang at a different distance or with a differently curved fold with every exposure; the photocell is constantly moved and particles inside may come loose and shift, or the wire may eventually fray and break.

Dirt may build up which is not noticed until someone cleans the top, removes the dust and consequently changes all exposure values; glass cleaning foam spray may be used that is carefully wiped off the glass but not off the photocell; another light nearby changes the intensity the cell will see; someone with light clothing standing near may reflect additional light onto the photocell.

Some users mount the cell on the frame to compensate for varying light intensity when the light is moved closer or further away. The intention of moving the light closer is to cover a smaller area with higher intensity for shorter exposures. Since the prime cone of illumination becomes smaller the light is more concentrated for a shorter exposure. Yet the photocell now finds itself positioned outside of this cone. It was not moved in the same geometric ratio (see illustration #11). In effect, when the photosensitive material sees more light for a shorter exposure, the photocell sees less and the integrated units run slower for a much longer time. This is the exact opposite of the required effect.

Even if the light is not moved in or out, the photocell still sits at the edge of the cone of light. In the center, the light generally shows great evenness, but not at the edge. Here the falloff is very rapid. The slightest movement of the light may have little effect within the exposure area itself, but it certainly affects the photocell and the corresponding exposure time greatly.

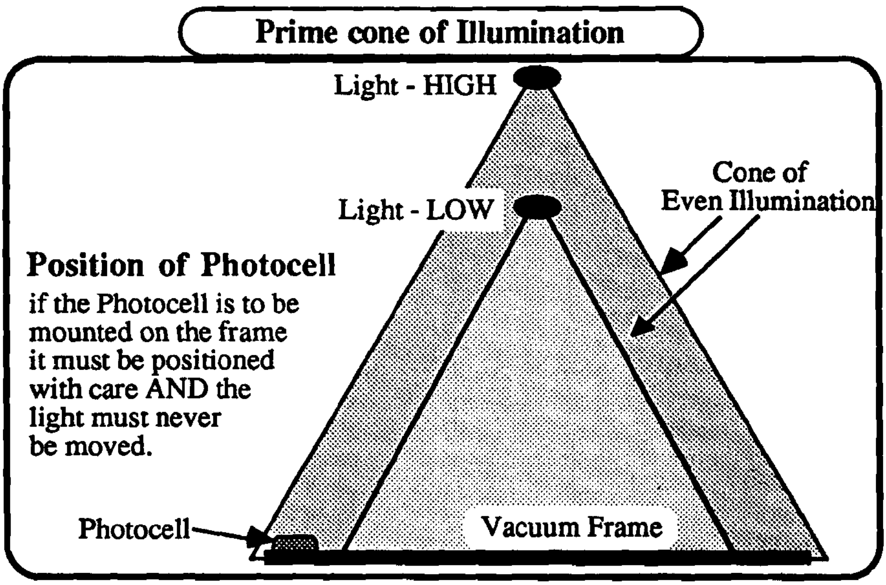


Illustration #11

The emission, the radiant energy emitted by the lamp, will vary as discussed above. If it does, such variation is exactly the same, no matter where a reading is taken, near the lamp or far away. Mounting the photocell near the lamp, into the light housing, has been accepted by Olec as the most logical solution and has proven its worth in thousands of installations. It is done with consideration for the potential heat build-up by mounting it in the cold air plenum with IR filters.

CONTROL of EXPOSURE LIGHTS:

Light integrators used for contact exposures accomodate essentially three types of light sources: filament lamps (Quartzlights) #1, quick-start mercury vapor or halide lights #2, and halide UV sources that rely on stand-by, low power cycle and shutter controlled exposures #3.

#1 - Filament lights are almost unaffected by ambient temperature and react to voltage only. They feature a very quick start-up ramp of about 1/50 to 1/10 of a sec that is repeatable with every exposure. If these lamps were of higher efficacy they could function as first choice every time. Due to their poor energy conversion factor in the blue and UV range, that we need for exposure, they find limited but important applications.

#2 - Quick-start, sometimes erroneously referred to as "instant-start," lights use gas discharge lamps of the mercury vapor type. A few can operate with a limited number of the more efficient halide lamps. All these lamps rely on the additives to the gas fill becoming vaporized and emitting spectral radiation of specific wavelengths. Consider that one of the typical elements in use is iron with a melting point of 1530°C, 2786°F, and a much higher vaporising temperature. The lamp must be heated up to such high temperature levels and that does take time, no matter which system is in use.

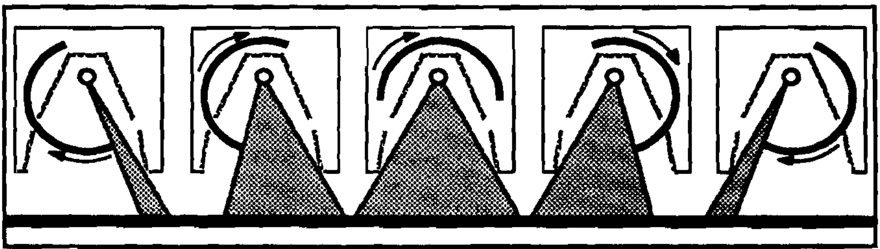
#2a - The fastest of the quick-starts rely on micro-wave energy. This is not only very expensive in initial cost but also in continuing maintenance. It still takes several seconds until ALL additives are vaporized and the radiation is stable. This start-up ramp is not repeatable or predictable and depends on ambient temperature and previous lamp condition. Therefore precise exposures under about 20 or 30 seconds are difficult to repeat. On longer times the error becomes negligible. The other difficulty is in fast repeating exposures, because such lamps will not restrike until cooled down, about 20 seconds.

#2b - Ballast quick-starts are lower in cost initially and during use. They do have the same problems of warmup time, in this case quite a bit longer than micro-wave. Times to a stable output may be 20 seconds or more. This is longer than the total length of many exposures using shutter units. During warmup the color of the light varies as temperature plateaus are reached where different additives vaporize and change spectral radiation as well as electrical characteristics.

#3 - Shutter control lights are the only real "instant exposure" devices. The lamp is always on at a lower power level but maintaining high internal temperature to keep all additives in a vaporized state. With the "expose" command they switch to the high current mode and the shutter times the exposure. Short exposure times can be repeated with great accuracy even in short succession. The Olec rotary, light tight, no-service shutter is shown in illustration #12.

Careful examination shows that all shutter lights are not created equal. Some have very high power consumption during idle with the corresponding heat build-up and short lamp life. Added are histories of expensive shutter and other repairs. Based on such negative experiences, decisions or comparisons are made at times that do not take into consideration the latest developments in technology. Olec has been a pacemaker in solving these difficulties.

To sum it up: "Integrators are essential for consistent and repeatable results."



SERVICE-FREE, ROTARY SHUTTER
for EVEN ILLUMINATION

Illustration #12

EVENNESS:

Evenness is most difficult to evaluate. First one must find the way that evenness can be measured. There cannot be any question that full size work sheets or test patterns with fine dots and micro-lines are the best criterion. Smaller test patterns should be placed in the center, the corners and, if any are left, along the sides. If only four are available it is best to check one quadrant for coverage first, then possibly transfer the strips and check the others. In the end it comes down to this: if it works it's right. But what works?

Continuous-tone step-scales should never be used for tests of evenness. A step scale, like any continuous tone film, has more density when viewed from an angle rather than perpendicular, the way a densitometer sees it. The actual change as measured is close to the cosine of the angle of incidence (see Illustrations #13 + 14). Any measuring device that changes its characteristics under test conditions cannot be used as reliable standard or test instrument.

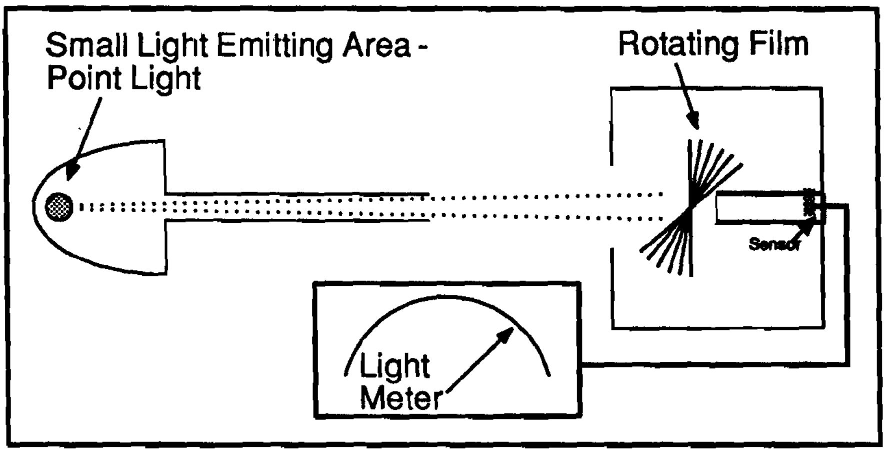


Illustration #13

Illustration #13 shows our measuring device to test the transmission falloff of a continuous tone film. Illustration #14 displays the results together with the calculated cosine curve. This is the effect of the increasing density of the test strip only. It is taken at a fixed distance and angle of light in relation to the photosensor of the light meter. It should not be confused with the cosine effect that causes a reduction of effective illumination due to the angle of the sensitive material. It also does not include the falloff added in the corner of an exposing area due to the increased distance from light to frame.

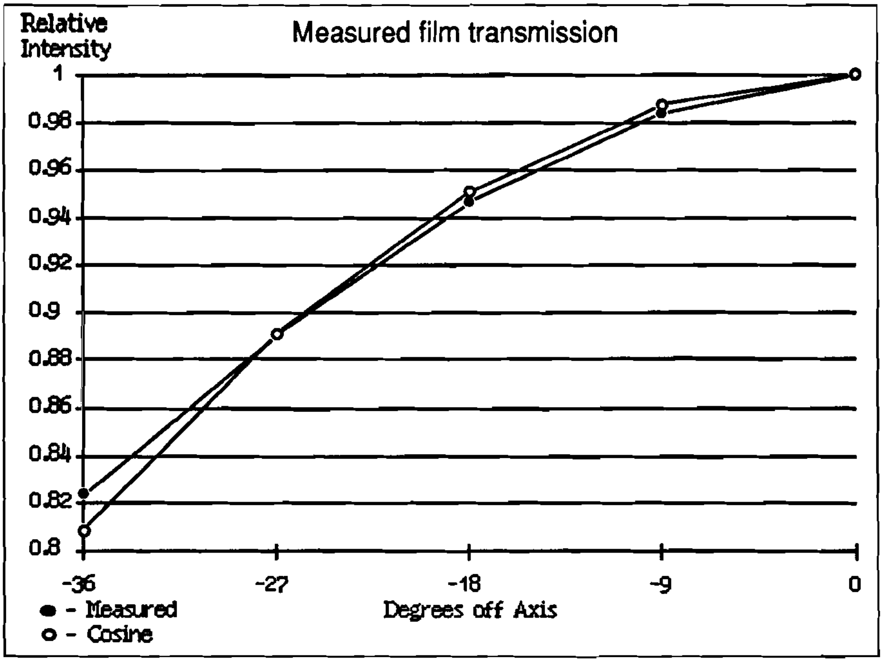


Illustration #14

It should be considered that the angle of incidence in the corner of many frames is greater than 36°. At 36° the error incurred is already close to 20% with a collimated light. Conventional, large reflectors may show a lower rate of decay, but then the resolution of the reproduced copy is lower. It is your choice: use collimated light for high resolution and reproduction fidelity or a soft source for easier workability under conditions lacking cleanliness with resulting lack in overall quality.

Continuous tone step scales are of great value in establishing the basic exposure time required for adequate results. Such measurements and tests are made in the center of a frame only, using perpendicular light.

A low cost, quick test for evenness can be made with blue-line paper partially exposed without any test pattern or step scales. It is important to recognize that some films or papers are not entirely even in coating, nor are processors even. To see if an uneven pattern of illumination is produced by lights, make several exposures with the blue-line material, using it in various directions and processed differently. If the pattern shows the same shape, the lighting is uneven.

Forget light meters or radiometers for tests of evenness, unless they are specifically designed to measure angular light *without* compensation for the cosine effect. Most meters are made to record perpendicular light only.

The Best Proof for Evenness: The only real way to test, while by no means perfect, is an actual exposure. Try exposing 2-5%, 50% and 95-98% dots in the corners and the center of the frame. With a full size screen tint you may be able to detect hot or cold spots, even slight unevenness, much better than with strips. The eye can detect slight changes in density that can be recorded with the densitometer.

The name of the game is to reproduce dots and lines, not continuous tones. If microlines and small dots reproduce well over the total area you can trust that you have even illumination, sufficient for your job.

Do not mount the light higher than necessary. It is often assumed that ALL lights should be mounted and tested at the same height. WRONG!

It reminds me of a story from my youth. I can never forget the joy I experienced when my uncle presented me with a flashlight. This flashlight had a variable beam: I could focus it to light up objects far away, or I could spread out the beam for broad coverage at closer distance.

Everyone working in graphic reproduction should own such a flashlight. It shows dramatically that lights can be designed to cover a wide area at a specific distance, be it far or near. Light manufacturers should publish accurate data and some do. Unfortunately there are no standards, nor do some understand that a salesman's enthusiasm for his product does not change the facts.

Olec specifies the distance at which a light should be mounted. This measurement is based on the diagonal of an area to be covered. Different Olite

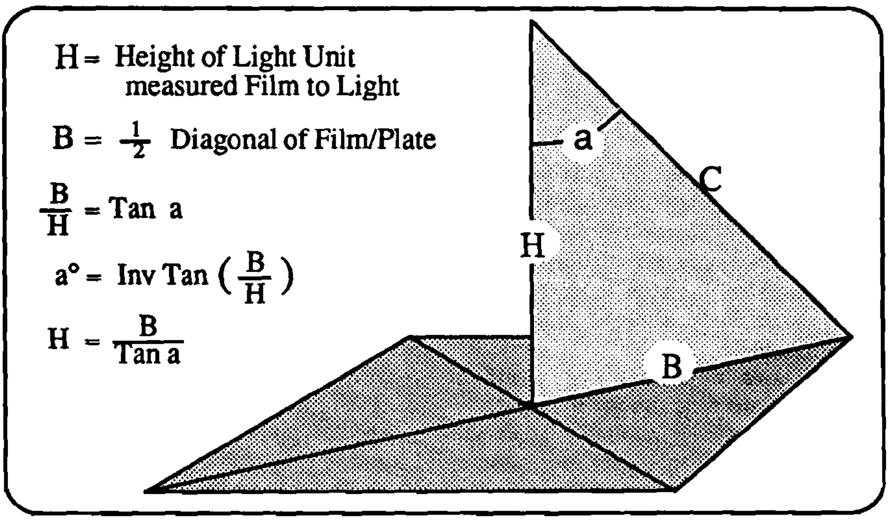
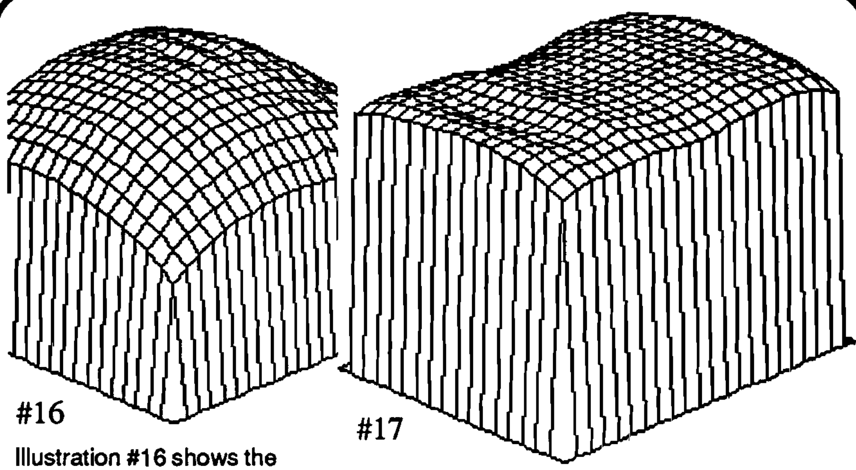


Illustration #15

lights and models feature varying coverage. 5 and 10 kW halide printing lights multiply the diagonal by 0.7 to 0.85 max., for instance. Raising the light any higher will not produce further noticeable improvement. The diagonal is based on a ratio of 3x4. Other shapes should be adjusted in proportion. #15 shows how to establish distances for different lights and sizes.

Olec developed a robotic testing unit, programmed to sample-measure the light intensity at predetermined intervals in the X and Y dimensions. The charts herewith, #16-17, represent light mountains measured over a 30x40", 75x100cm, exposure frame with 300 measurements taken 2", 5cm, apart in both directions.



#16

Illustration #16 shows the pattern of a conventional round reflector at 50" with 45% corner fall-off.

#17

#17 shows the even pattern of a modern, square reflector at 36" distance with less than 12% variation. (OLITE 10 kW dual lamp system)

Accurate Light Distribution Patterns

RESOLUTION:

Throughout this paper the basis for precise reproductions have been explained. These all, vacuum, exposure time, and evenness, have an indisputable effect on resolution. But should the highest and most critical sharpness be of essence, consideration should be given to the following:

It has been clearly established that the collimation of light sources is of importance. That collimation is often misunderstood. Companies have gone to great lengths getting sophisticated and terribly expensive optical systems with "point lights," mirrors and all. Yet some of the results can be equalled or bettered with simple, high power direct illumination.

Fact is that some of the definition of reproductions is directly dependent on the resolving power of the sensitized material and the thickness of the original.

Using a standard 5 kW Olite halide printing light over a 30x40", 75x100cm, vacuum frame at a height of 40", 1m, we reproduced 1/2% dot, 133 line screen, and the equivalent microlines, center and corner equally. This test was conducted with Diazo film. There is plenty of evidence of this kind that proves to us that a light with computer-designed reflectors, optimized for collimation, can perform the most precise tasks of large size reproduction.

Investigating the resolution power further, we found that it was greater with shorter wavelengths. Sacrificing speed by a factor of about 10 to 30% we were able to gain significantly in sharpness on some emulsions.

The answer is in the interreaction between light/UV and the sensitized emulsion. Certain aberrations take place in the penetration through the original as discussed in previous papers of the author (TAGA 1985, PCMI 1986).

Further than that is the consideration of halation and lateral travel and reflection within the sensitive emulsion, often referred to as undercutting. (In difference to undercutting caused by incomplete vacuum and spacers)

Halation and undercutting is caused by reflection of light from the backing of the material or off the sensitized particles, such as silver grains, within the emulsion. Long wave light, such as red, is easy to reflect. The shorter the wave length, the less reflection and diffraction. UV has such a short wavelength that the problems of scatter light and undercutting are greatly reduced to produce a substantially sharper image. This appears not only on E to E, Emulsion to Emulsion, but even through the base or a spacer.

Utilizing lamps of shorter spectral emission, often with a filter that will limit the effective radiation to the spectrum shorter than 400nm can greatly improve performance in regard to resolution. To facilitate these requirements Olec provides fixed, moving and motorized - fully automated filters and holders.

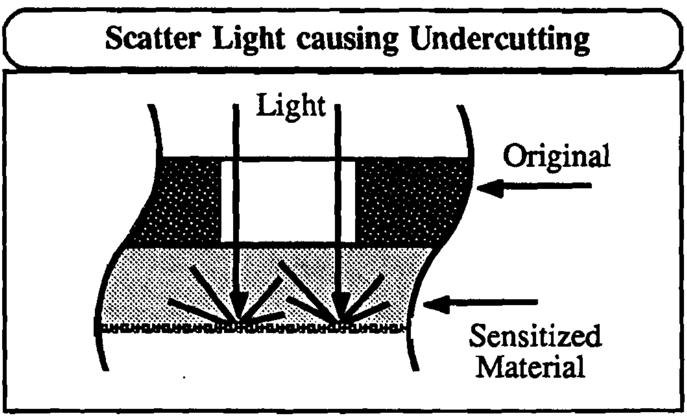


Illustration #18

It has been pointed out that the size of the light has an influence on resolution and that is quite correct. The size of the light emitting area is not necessarily the full size of the reflector. Olite reflectors are designed so that only the portion behind the lamp, looking from the point of incidence, is used as prime reflecting surface. This greatly reduces the light emitting area. Such design can not be accomplished with high reflectivity, specular material with pebbly surface. With lights using that material the full front area of the reflector including the reflective hood becomes the active light emitting area.

Some users claim that a change in size of reproduction in the corners and on the sides is caused by the light or size of light emitting area. Fact is that the center of the exposure frame sees the largest dimension of the light. Towards the outside, the image of the light emitting area becomes smaller for two reasons: the angle to the light makes it appear smaller by the cosine and the distance light to material is longer and therefore reduces the image further.

In reality there are no true point lights. Not considering other errors, such as undercutting or halation, the dot reproduction should have a soft shoulder, since it is the reproduction of the light in reverse (see illustration #19).

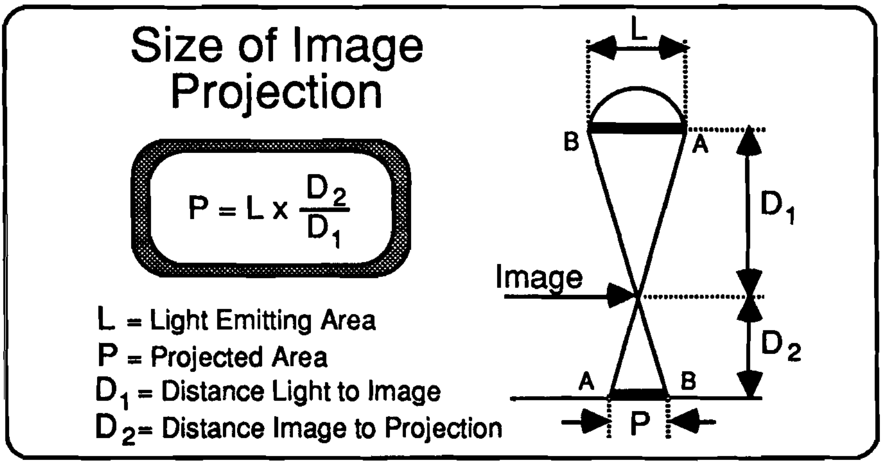


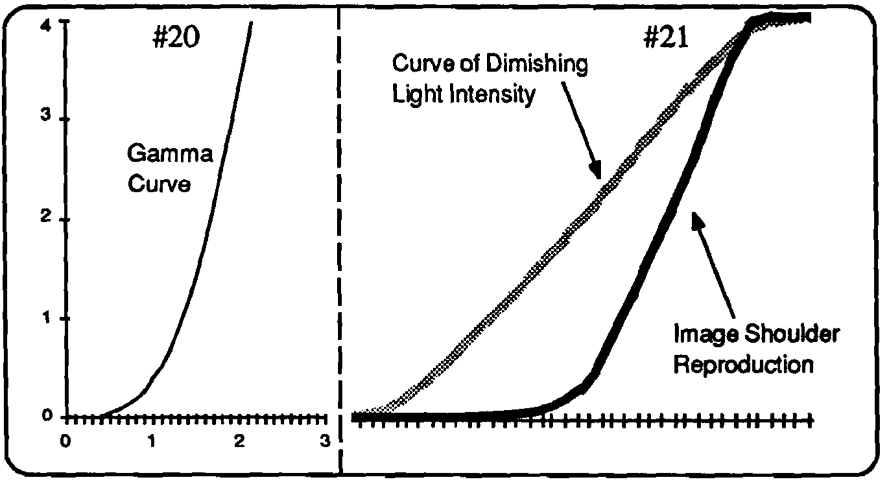
Illustration #19

The edge of an image is projected onto the sensitized material as pictured in illustration #19. "P" is the projected image. At A the material sees just a small portion of the light that increases steadily until it reaches point B. From here on it can no longer increase being fully exposed to all the available light energy.

Using a light dimension "L" of 10cm, 4", "D_1" of 1m, 40", an emulsion thickness of 5μm, the shoulder of an image would slope by 1/2xP=10μm, .1mil. With a conventional light with a large round reflector and reflective hood of 50cm, 20", the shoulder amounts to 50μm, .5mil. With a 100μm, 4mil, spacer this dimension becomes more sizeable. In this case the full dimension "P" applies. The shoulder "P" is 400μm, 16mil, with a 4" lamp, 2000μm, 79mil.

These are quite drastic measurements that would theoretically preclude the reproduction of fine images in any other manner than E to E. As is mentioned on a previous page, Olite lights can reproduce 0.5% dots through a spacer. This is because of the excellent collimation of the light and the effect of the high contrast of the material, in this case diazo. It is the same effect that shows only two or three steps exposed on a multi-step continuous tone test strip.

Illustration #20 shows a Gamma curve, illustration #21 the decrease of illumination at the edge of an image and the corrected image with a steeper shoulder.



Illustrations #20 + 21

It is our recommendation that careful tests be conducted to establish a realistic requirement. It does not make sense to demand standards of accuracy that are beyond the parameters such as the limitations of a printing press. One should also consider the cost of a clean-room with resolution beyond ordinary need. That cost can be prohibitive.

Once the requirements for accuracy and speed are set, it should become a matter of actual testing to establish the optimum combination of equipment and material. It is one matter to see tests conducted in a laboratory, another to transfer performance to your place of business. Try to buy equipment with a performance guarantee by the manufacturer, subject to return for credit.

Make sure that the supplier understands what you need!

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