

# Fill Flash Photo Luminescence to Photograph Luminol Blood Stain Patterns

*Fred E. Gimeno*

*Gary Alan Rini*

*Police Department  
Denver, CO*

Luminol (3-aminophthalhydrazide) was first synthesized by Schmitz (1902) [1] and had its first forensic application in 1939 by Specht [1-2]. Primarily, luminol is used as a *presumptive* test for minute (trace) amounts of blood which may have been diluted as much as 1:5,000,000 [3] in an attempt to conceal it from the naked eye.

As an investigative tool, luminol can be applied to those crime scenes in which there is reason to believe that blood has been shed and that an attempt has been made to conceal that fact by washing away the evidence. Once removed from sight, this evidence can be detected hours, days, or even years [2] after it has been removed from sight.

Using the classical recipe of luminol, sodium perborate, and sodium carbonate in distilled water[4], occult (hidden) blood can be visualized in the form of a blue-green/white glow (chemiluminescence). With very few exceptions, this luminescence occurs as the product of a chemical reaction between the luminol and the hemoglobin in the blood.

Hemoglobin is that portion of the red blood cells which transports oxygen on a cellular level. When exposed to air, the red blood cells will break open and expose the hemoglobin. It is in this condition that the luminol, once applied, will react with the trace amounts of blood to produce a blue-green/white luminescence. Caution must be used in the interpretation of the results of the luminol processing,

Received: 1 December 1988

Revised ms. received: 10 March 1989

Accepted: 10 March 1989

J. Forensic Ident.  
39 (3), 1989 / 149

as the luminol will also react with other materials such as copper and copper alloys. However, with practice and good judgement, the chemical reactions observed as the result of a luminol application to these items is easily discernable from those luminol reactions attributable to trace amounts of blood.

There have been questions raised as to the interference of the luminol with other serological tests. Since there are conflicting reports as to the effect luminol has on these subsequent tests, care should be taken to document and collect *visible* blood in adequate quantities for serological testing, prior to any application of the luminol. However, if one reminds himself that luminol is used to detect *trace* amounts of *hidden* blood, then this caution becomes unnecessary.

Traditionally, the method for documenting this reaction has been through the use of black and white still photography [5]. This method requires the investigator, in total darkness, to first locate the stain with luminol, and then reapply the luminol for photographic purposes once the necessary camera equipment has been positioned over the stained area. Thereafter, a 30-40 s exposure is required to document the luminol reaction.

The results of this method of documentation are essentially white figures on a black background (Figures 1 and 2). The significance of the resulting photograph is evident, generally, only to those involved in the processing of the scene. The entire procedure, and its results may lose its impact in a forensic setting by the lack of detail and precision of the photographic technique.

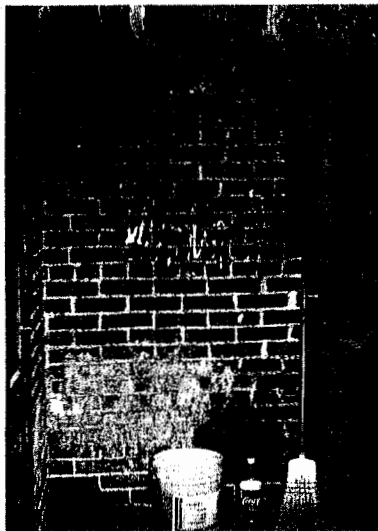


*Fig. 1. Typical luminol photograph.*



*Fig. 2. Luminol photograph. No reference points to denote orientation or size.*

In order that this process be appropriately documented so that it will not lose its value to judge and jury, a new technique has been developed to enhance the documentation of the luminol reaction. This has been achieved through the use of fill-flash photography. By using this technique, properly called "fill flash time exposure," it is possible to get quality photographs of the luminol reaction in the context of a fully detailed picture of the articles in question. To accomplish this, it is necessary to combine both time exposure and fill flash photography. The time exposure is necessary in order that a sufficient amount of light, generated from the luminol reaction, be allowed to accumulate in intensity on the film. The fill flash will be intense enough to record everything in the field of view as it would appear under normal lighting conditions. This technique will yield negatives that can separate subtle differences in contrasting articles (see Figures 3 and 4).



*Fig. 3. Same scene as depicted in Fig. 1 with fill flash added. Compare the luminescence.*



*Fig. 4. Same scene as depicted in Fig. 2 with fill flash added. Compare the luminescence.*

#### **Materials and Methods**

*A camera equipped with a 'B' setting.* This is necessary since it is necessary to make a time exposure, and the shutter must, therefore, be locked open.

*A sturdy tripod* to keep the camera immobile during the time exposure and during the final *f*-stop change.

*A cable release.* Preferably a locking cable release to keep the shutter open throughout the entire exposure.

*A strobe flash unit.* This unit will provide the fill flash after the initial time exposure.

Some type of *opaque material*, such as black plastic electrician's tape. This will be used to reduce the light delivered by the strobe.

*Luminous paint.* This is helpful especially if anyone must move about in a darkened room. The luminous markings will help avoid accidentally tripping over the tripod. Accidents of this type can be avoided by spot painting the legs of the tripod with luminous paint. This paint will make the tripod visible in the dark without affecting the exposure. Also, exposure tests can be made by simulating bloodstain luminescence with luminous paint. Luminous paint can be recharged with normal light and then allowed to fade to the desired brightness. This is much less expensive than initiating exposure tests with luminol.

*Measuring tape.* Since the distance from the flash to the subject is needed, not the distance from the lens to the subject, a measuring tape is needed to accurately determine the distance. Accurate measurements become more critical as the contrast between the luminescence and the treated surface decreases.

*KODAK Tri-X Pan film, ASA 400.* Unlike color film, this black and white film can be pushed to an ASA rating of 6400 and beyond.

*KODAK T-MAX developer.* This black and white film developer is easy to use and helps to minimize film grain which is a normal by-product of push processing. Also, minor fluctuations in time and temperature will not have devastating effects on the film.

### *Creating an Exposure Chart*

A great variety of strobes are in use today. Consequently, it is not possible to create a universal, single exposure chart that can be used for every flash unit.

The method for deriving proper exposure control is as follows:

Using graph paper, draw an X axis along the bottom edge and a Y axis along the left margin. On the X axis, from left to right, indicate 2 foot increments from .66m (2 ft) to 10m (33 ft). Spread out the increments as wide as possible to aid in charting. On the Y axis label every other line with the sequence of *f*-stops. Begin closest to the X axis (at the bottom) with *f*-32 and at intervals equal to those used on the X axis, record progressively larger whole *f*-stop numbers to the maximum aperture of the lens (Figure 5).

Regardless of the make or model of strobe that is used, the delivered output will have to be reduced since the film is being exposed at an extremely high ISO (6400); consequently, a low level of illumination is needed to produce a proper exposure. It is necessary to mask the strobe with some opaque material to reduce light output. If the strobe is dedicated, it may help to get consistent results by switching to manual or to use a separate hot shoe. If the strobe has a variable power selector, use the lowest power setting. It is important to be able to reliably duplicate test results. The method of masking is important, consistency is the key.

One method of masking is to stick black plastic tape over a piece of paper. Cut this down to fit over the flash window then use a paper punch to open a hole in the center. Another possibility may be to mask half of the flash window with black plastic tape, then mask half again as needed. It may be very difficult to maintain consistency if this technique is carried too far. A third possibility may be to have

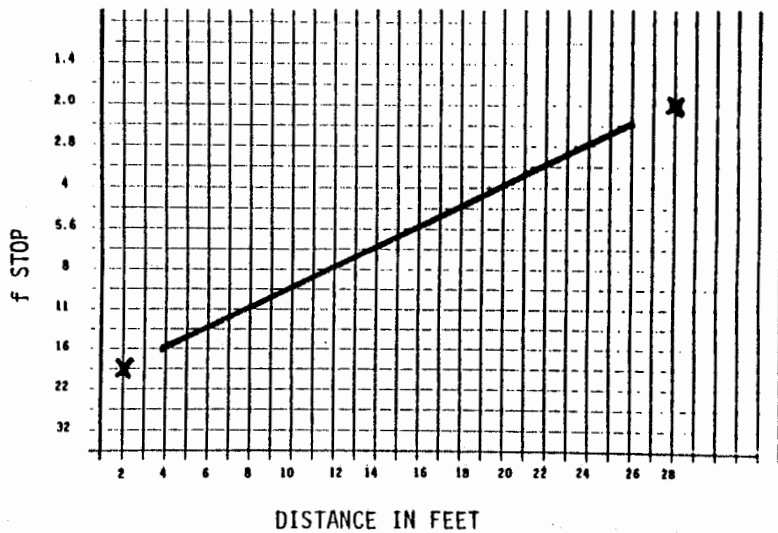


Fig. 5. Example of an exposure control chart for a partially masked Vivitar 51 strobe unit. Each strobe/mask combination will require its own chart, determined by the method given in the text.

a darkroom technician make some masks using KODAK Kodalith sheet film. These can be cut down to fit over the strobe's flash window or to fit in a filter slot.

*Initial Luminescence Testing*

Luminous paint approximates the luminescence of the luminol: blood reaction with less expense and bother. Obtain a small jar of luminous paint from a hobby or craft store and paint it onto the surface of a white or light colored article such as on cloth, paper or cardboard. Paint some type of recognizable geometric design on the item to ensure that if another light source or light leaks are present, they will not be mistaken for the test design. Initial test exposures should be made at  $f$ -2.0 for 35 to 40 s. The luminous paint should be "recharged" before each exposure is made by exposing it to room light. This step is necessary so that similar levels of luminescence are present test-to-test. Develop the negatives and determine a proper exposure.

*Initial Fill-Flash Testing*

Fill flash exposures will be made in two stages: a time exposure at  $f$ -2.0 will be made to capture the luminescence of the luminol reaction, and then while the shutter is still open, the aperture will be adjusted to yield a proper fill flash exposure, and the strobe fired.

In order to determine the proper aperture/distance ratio for ISO 6400. Test the strobe and mask combination by making a series of test exposures. Position the

flash 3.9 meters (10 ft) from the test object, and make flash exposures at  $f$ -11, between  $f$ -11 and  $f$ -8, and at  $f$ -8. Examine the negatives to determine if the strobes output needs to be altered. There should be a good separation between the luminescence and the white article. If the negatives are too thin, the strobes output needs to be increased. Do this by removing some of the mask, then retest. If the negatives are too dense, reduce the output by closing down more of the window with tape or add layers of white translucent plastic or transparent plastic, then retest. Strive for a light output which yields a properly exposed negative at about  $f$ -11 at 3.9 m (10 ft). When proper negative density has been determined, mark the chart at the point where 10 ft intersects with the optimum  $f$ -stop.

Move the camera, tripod and strobe to 1.2 m (4 ft) from the test object and make a series of five test exposures. Start with  $f$ -11, and at  $1/2$   $f$ -stop increments, work down to  $f$ -22. Move the camera, tripod and strobe back to 6.1 m (20 ft) and make another series of test exposures from  $f$ -2.0 to  $f$ -5.6 in  $1/2$   $f$  stop increments. Develop the film and determine which aperture setting produced the most acceptable negative. Record these intersects on the graph.

The 3 intersects should be connected. A nearly straight line should result. This graph should work for most luminol situations. To "fine tune" the exposure scale, luminol and occult blood must be used.

### *Final Testing*

As mentioned previously, documenting luminol by this procedure is a two step process: first a time exposure is made at  $f$ -2.0 to record luminol luminescence, followed by a fill flash illumination of the background. In order to ensure proper separation between luminol luminescence and the fill flash, both steps must be tested on the same negative.

For each  $f$ -stop to be verified, five pieces of white cloth will be needed. Make a recognizable pattern on the cloth using blood (e.g., a hand print). Use a laundry marker or some device to indicate on which side of the cloth the blood is deposited. Let the blood dry and then launder the cloth to remove the majority of the stain.

Repeat the fill flash procedure as outlined in *Initial Fill-Flash Testing*, above. It should only be necessary to make exposures one stop above and below the previously determined exposure value, in  $1/2$   $f$ -stop increments. Develop the film and record the best exposure. This again should result in a nearly straight line that is similar to the original chart.

Since the luminol: blood reaction fades fairly quickly (ordinarily within 1 min) and becomes diluted over time, there are few opportunities to accurately photograph luminol at a crime scene. For that reason, an accurate exposure chart should be constructed at .5m (approx 2 ft) intervals from 1.5 m (approx 4 ft) to 10 m (approx 30 ft).

### *Exposure Procedure*

Attach the camera to the tripod. Turn the shutter selector to the 'B' setting and attach the cable release. Focus the camera on the desired subject. Use a measuring tape to determine the distance from the subject to where the **strobe** is going to

be fired. Do not use the distance from subject to camera unless the strobe is going to be fired near the camera. (It is possible to set up multiple cameras and use only this one strobe for the fill light.)

Open the lens aperture to  $f$ -2.0 for the luminescence portion of the exposure. Focus on the object to be photographed. Since the luminol: blood reaction produces a low level of luminescence, a large aperture opening allows a maximum negative density to be achieved. Set up the camera perpendicular to the suspect surface so that depth-of-field considerations are minimized.

Before the fill flash exposure is added, the aperture must be closed down to prevent over-exposure. Therefore, before proceeding with the time exposure, use the exposure chart to determine the correct flash exposure for the indicated distance. The camera will have to be adjusted to the new  $f$ -stop in the dark before the strobe is fired.

Turn off all lights and block any external source of light which may leak in through windows and/or vents. Cock the camera and in the dark, use the cable release to lock the shutter open. Now apply the luminol.

After 30 to 40 s, turn the aperture ring to the new  $f$ -stop. If necessary, use the strobe's ready lamp to illuminate the chart to find the flash aperture setting. The ready lamp can also be used to illuminate the aperture ring to find the new  $f$ -stop. If this is done, the light from the ready lamp must not be permitted to enter the lens. Aim the strobe at the subject and fire once, then close the shutter.

### *Film Processing*

To process the exposed film, prepare the stock solution of T-MAX developer according to instructions on the container (1 part developer to 4 parts water). Process the film for 16 min at 24°C (75°F). Agitate after 1 min and then again after every 5 min. Fix and dry the film according to the data sheet recommendations.

Film that is developed beyond its designed limits to obtain a usable negative is called "pushed" or "push processed." The benefits are not without drawbacks. Pushed film tends to be grainier and usually has a higher degree of contrast. Neither of these drawbacks is serious.

The film grain is hardly apparent when an 8 x 10 inch print is made. The contrast can be brought down by using a low contrast paper or a variable contrast paper and filter such as a number zero or a number one.

### *Exposure Considerations*

A 35 to 40 s exposure at  $f$ -2.0 will ordinarily produce sufficient negative density for normally bright luminol luminescence. However, take note that:

1. If the luminescence is particularly dim, the exposure must be extended or the lens must be opened to  $f$ -1.4 or both. (The ability to judge relative luminescence levels can only be determined through repeated experimentation.)
2. If the luminescence is bright, the exposure time must be reduced or the lens stopped down.

Since it is not unusual for bloodstains to luminesce longer than 35 to 40 s, it may be possible to obtain more than one frame. It is not advisable to attempt an

extra long exposure on a normally bright to extra bright luminol reaction. Too long an exposure may cause the image on the film to bleed out. At the very least, this can result in a serious loss of potential detail along with any well defined boundaries. Worse yet, the image of the luminescence may spread beyond the edge of the surface area on which it appears.

## Conclusion

By using a fill flash while photographing bloodstain luminescence, it is possible to produce photographs which are both graphic and properly oriented.

The parameters of routine flash photography are the only limits governing this fill flash photo luminescence technique. Being inexpensive and as portable as a tripod and a 35 mm camera, good quality photographs can be made in tight, cramped quarters such as a closet or furnace room. Entire rooms can be covered by using a camera equipped with a wide angle lens while at the same time getting the tight, detailed shot by using a second camera equipped with a telephoto lens.

For further information, contact:

Fred E. Gimeno  
Technician  
Denver Police Department  
1331 Cherokee Street  
Denver, CO 80204  
(303) 937-4444

or Gary Alan Rini, B.A., M.F.S.  
Sergeant  
Denver Police Department  
1331 Cherokee Street  
Denver, CO 80204  
(303) 869-7061

## References

1. Gaensslen, R.E., *Sourcebook in Forensic Serology, Immunology, and Biochemistry*, U.S. Department of Justice, National Institute of Justice, Washington, D.C., 1983, pp 112.
2. Proescher, F., and A.M. Moody, "Detection of blood by means of chemiluminescence," *J. Lab. and Clinical Med.*, 24, (1939), pp 1183-1189.
3. Kirk, P.L., *Crime Investigation*, 2d ed, (J.L. Thornton, Ed.), John Wiley & Sons, New York, 1974, p 184.
4. Lytle, L.T., and D.G.Hedgecock, "Chemiluminescence in the visualization of forensic bloodstains," *J. Forensic Sci*, 23, 1978, p 500.
5. Zweidinger, R.A., L.T.Lytle, and C.G.Pitt, "Photography of Bloodstains Visualized by Luminol," *J. Forensic Sci*, 18 (4), 1973, pp 298-302.



*Technical Note*

# Fill Flash Color Photography to Photograph Luminol Bloodstain Patterns

*Fred E. Gimeno*

*Police Department  
Denver, CO*

In a previous article [1] a technique for photographing the luminol process using fill flash black/white photography was discussed. Recently, an alternative method has been developed by which the same information can be photographically recorded on color print film. This method will yield consistently high quality color prints of the article in question in context with its surroundings.

## **Materials and Methods**

The following equipment is used: a camera equipped with a 'B' setting, a sturdy tripod, a cable release, a strobe flash unit, and any color print film with an ASA/ISO of 400

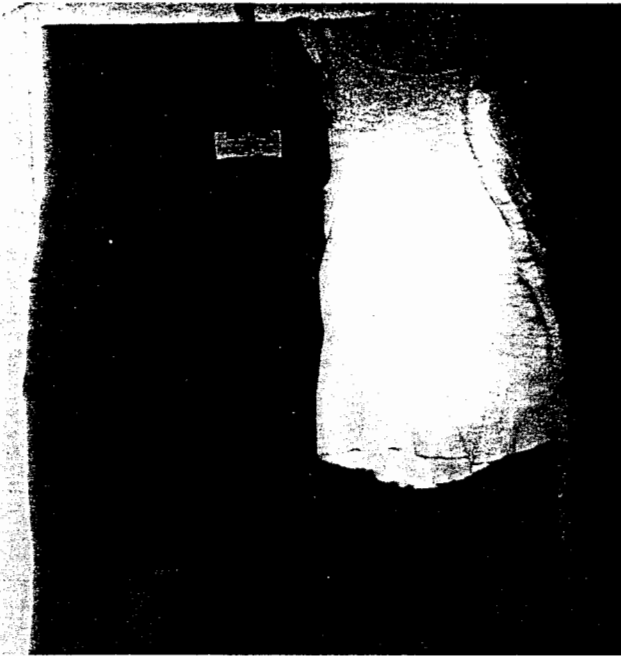
Attach the camera to the tripod, turn the shutter selector to the 'B' setting and attach the cable release. Focus the camera on the desired subject. Measure the distance from the subject to the strobe. Read the strobe's exposure calculator dial to determine the proper exposure for film rated at ASA/ISO 400. The actual flash exposure will not be made at the "indicated" exposure, but at 2 *f*-stops stopped down from the "indicated." For example, if the flash index indicates that at 5 m (16 ft.) *f*-8 is recommended, use *f*-16 instead.

To make the fill flash/time exposure, open the lens to *f*-2.0. Darken the room, lock the camera open and apply the Luminol. Expose the color print film from 40 to 80 sec, depending on the brightness of the luminol reaction. Finally, rather than using the indicated *f*-stop, close the aperture down two *f*-stops. (See above) In darkness, turn the aperture ring down to the new *f*-stop. Fire the strobe and then close the shutter.

---

Received: 26 June 1989    Accepted: 1 August 1989

J. Forensic Ident.  
39 (5), 1989 \ 305



*Fig. 1. Illustration of the technique described in this paper [Note: original supplied for publication was a color photograph (Ed.)]*

Discoloration can be noted in the lower left portion of the photo. This results from spontaneous luminescence of the luminol in the spray bottle during application. While spraying, the spontaneous luminescence was recorded on the film. To prevent this effect, an opaque bottle can be used. (A transparent bottle was used to apply luminol in this scene.)

Process the film normally. Prints made from these negatives will be well exposed, as any normally exposed color print film.

### **Conclusion**

By using a modified form of the fill flash photography technique for black & white documentation, it is possible to take color prints of the luminol process.

For further information, contact:

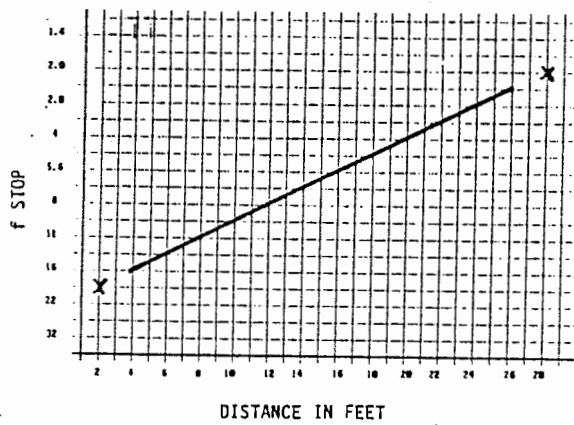
Fred E. Gimeno  
Police Department  
1331 Cherokee Street  
Denver, CO 80204  
(303) 937-4444

### **References:**

- 1 Gimeno, F.E. and Rini, G.A., "Fill Flash Photo Luminescence to Photograph Luminol Blood Stain Patterns," *J. Forensic Ident.*, 39 (3), 1989, pp 149-156.

*J. Forensic Ident.*  
306 / 39 (5), 1989

TO PHOTOGRAPH LUMINOL ON BLOOD AND ALSO RECORD THE SURROUNDINGS



PARTS LIST \*(OPTIONAL)

- Camera with a 'B' setting
- Tripod
- Cable release (locking\*)
- Luminous paint\*
- Hot shoe to PC adapter
- Insulated speaker wire\*
- Normally off push button switch
- Measuring tape\*
- Black electricians tape
- Vivitar strobe model #51
- Kodak tri-x pan film
- T-max developer

Cut the PC adapter off the hot shoe. Strip  $\frac{1}{2}$  inch of insulation from the wire and solder the optional length of speaker wire to the exposed hot shoe wires. Insulate the exposed connections from each other. At the other end, connect and solder the normally off switch. Make sure these wires are separate from each other.

Use black electricians tape to mask off the face of your Vivitar strobe. Mask  $\frac{1}{2}$  diagonally then mask  $\frac{1}{2}$  of the face vertically. This will cut down the delivered light, appropriate to photograph a luminous subject and surroundings.



With the camera on a tripod, set the camera on the 'B' setting. Attach the cable release. Open the f stop to 2.0. focus on the subject. Measure the distance to the camera. Turn off all lights, and block off any external lights (windows). Open the shutter and apply the luminol. After the luminescence has significantly dissipated, use the chart to determine the f stop that is to be used before firing the strobe. Stop down, aim the strobe and fire once. Close the camera shutter and process the film.

Process the film for 16 minutes in the T-max stock solution diluted 4 to 1 at 75 deg. F. Agitate after one minute then every five minutes thereafter. Fix and dry.

For a most acceptable print, use a low contrast filter such as a zero or a one. This is because film that has been pushed has a lot of contrast already built in.