TECHNICAL NOTE

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Processing Photographic Films by Infrared Inspection

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ABSTRACT: Modern advancements in the electronics industry have made infrared (IR) night vision instruments valuable tools in the photographic laboratory. Because the majority of black-and-white and color films are not sensitive in the IR portion of the electromagnetic spectrum, they can be handled and processed with the aid of infrared inspection devices. The overwhelming advantages of processing by IR inspection are numerous, but the primary benefit is to watch the latent image develop before your eyes.

KEYWORDS: forensic sciences, photography, infrared inspection

Infrared visual processing is a choice alternative over the use of chemical desensitizers or visual examination of processed film under very low safelight illumination. Chemical desensitizers are actually colored dyes that reduce the sensitivity of the exposed film to light without significantly affecting the latent image. One of the common chemical desensitizers is used as a prebath to the development step. After a specified time in the desensitizer, the film can be processed under safelight conditions. As an example, Kodak Tri-X Pan black-and-white (B & W) film can be desensitized and subsequently processed under a Kodak No. 1 (red) or OC (light amber) safelight. Black-and-white panchromatic films can actually be viewed for brief periods under very low safelight illumination in the latter stages of development. A green safelight is used when inspecting B & W panchromatic films because they are less sensitive to light at a wavelength of 520 nm. Total darkness is normally required during processing. However, when the development is at least 50% complete, the film can be inspected briefly under Kodak No. 3 (dark green) safelight illumination. Orthochromatic films (which are blue sensitive) can actually be developed under Kodak No. 1 (red) safelight without fogging the film (Fig. 1) [*1*].

Forensic scientists and law enforcement photographers are primarily concerned with common B & W or color films used for evidence and crime-scene photography. Desensitization chemistry is difficult to obtain, and visual light inspection is rather risky when crucial evi-

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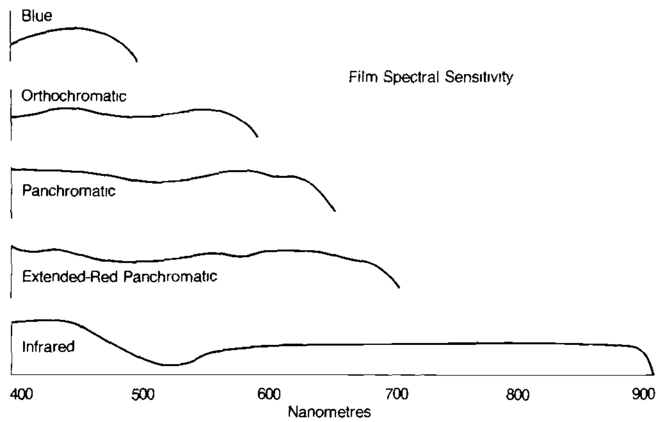

FIG. 1—*Spectral sensitivity of common black-and-white film. (Reprinted with the permission of the Eastman Kodak Company.)*

dence depends on the outcome of the photographic process. Therefore, infrared (IR) inspection is the safest method for monitoring the photographic process.

Commercial photographic laboratories are taking advantage of the ability to monitor processing steps, especially the development procedure, to insure that all is well with automated film processors. One of the best sources of IR illumination is provided by the Kodak No. 11 (IR) darkroom safelight filter [*2*]. Infrared safelight filters are available in both the 25.4- by 30.5-cm and the 14-cm diameter to fit the Model B and D safelights manufactured by the Eastman Kodak Company. The Kodak No. 11 filter transmits light in the portion of the electromagnetic spectrum above 780 nm (Fig. 2). The source of the IR radiation is one 15-W bulb contained within the safelight housing. This filter is opaque and appears black to the naked eye. Using the IR safelight and a portable night vision/IR instrument or instruments (Figs. 3 to 6), the photo technician or investigator may actually watch the development of photographic films proceed.

Infrared-sensitive films, such as Kodak High Speed Infrared Film B & W and Kodak Ektachrome Infrared Film, must be processed in total darkness and cannot be processed by IR inspection. Both films are sensitive not only to IR, but to all regions of the visible spectrum and shorter wavelengths [*3,4*].

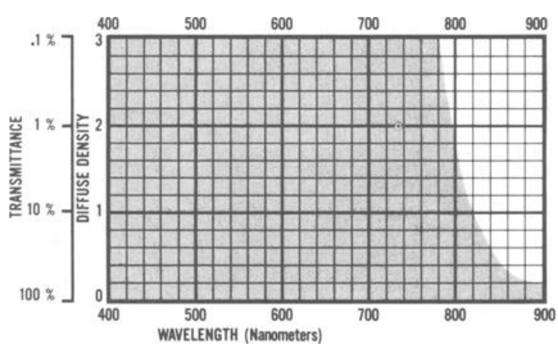

FIG. 2—*Transmission characteristics of Kodak No. 11 safelight filter (infrared). (Reprinted with the permission of the Eastman Kodak Company).*

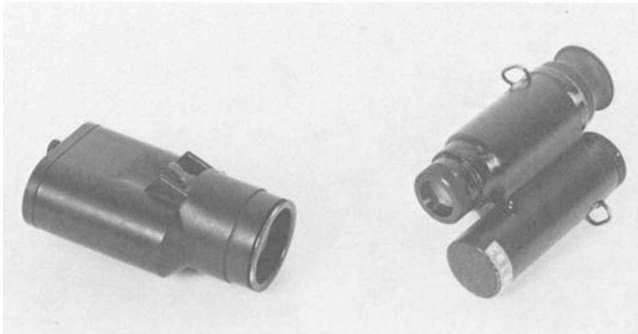

FIG. 3—*Infrared light source* (left) *and metascope* (right).

FIG. 4—*Oldelft infrared goggles with headstraps.*

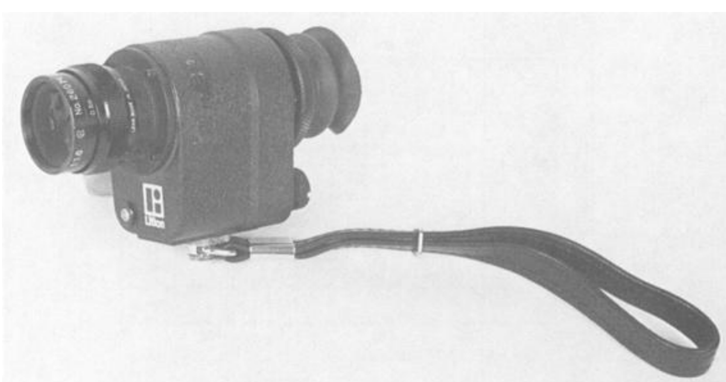

FIG. 5—*Litton M911 Pocketscope high-performance nightvision system.*

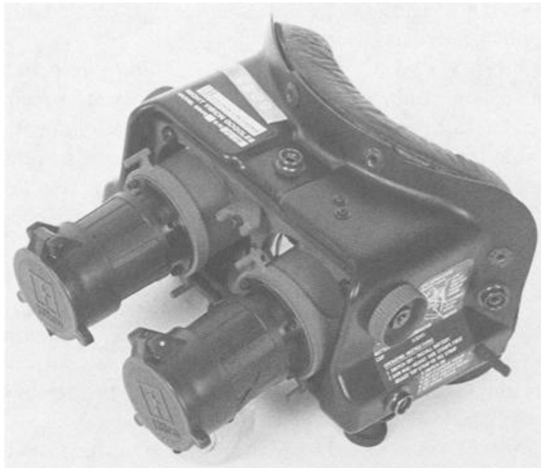

FIG. 6—*Litton Nightvision goggles (AN/PVS-5A) without headstraps. Infrared LED light source not seen in Fig. 7.*

Technicians are routinely faced with a dilemma of processing film exposed by another investigator or officer, and frequently, exposures vary in density. Exposures may vary greatly from one roll to another: frames may be overexposed, correctly exposed, or underexposed. Overexposed film can be "pull" processed when development proceeds too rapidly. Normally exposed film can be processed as recommended, and underexposed film can be "push" processed by extending development. The "push-pull" techniques may not be recommended by the film manufacturers because image degradation will be apparent in either situation. However, the experienced laboratory technician may be able to salvage valuable evidence using IR inspection to influence his judgment on processing. Alternate procedures may be required in the face of gross underexposure, but those specialized processing techniques are beyond the scope of this article.

Chemicals, tanks, thermometers, and related equipment can be clearly recognized using the inspection devices in the darkroom. Loading exposed film onto reels for processing becomes a simple, quick task that can be done by the apprentice without difficulty or error. Again, IR inspection will instill confidence in the technician and reduce the number of errors in the darkroom.

Typically, the darkroom layout is designed with a large "dry" area for loading film and storage of equipment. Ceiling mounted safelights Kodak OC (light amber), Kodak No. 1 (red), Kodak No. 3 (dark green), and Kodak No. 11 (IR) are all available at a nearby switch. In the "wet" area reserved for processing, the same safelights are used. Kodak recommends that the safelights listed above use a 15-W bulb for illumination and be no closer than 1.2 m from the film.

Night vision/IR viewers are commercially available and vary in price from $400 to 9000. The Metascope, a hand-held, monocular IR device was produced for the military, but it is now available in some photo trade catalogs for approximately $400. The price should include a small IR light source for close-up viewing.

Oldelft, a Dutch manufacturer, produces the Oldelft IR Goggles which sell for approximately $4900.

The Litton M911A night vision/IR Pocketscope is a palm-sized, high-resolution, monocular viewer and costs about $3900. The Pocketscope has a built-in IR light-emitting diode (IR

LED) and can be focused for close-up or distance viewing. Electronic signal amplification produces a near daylight representation of the work area.

The military version, AN/PVS-5A high resolution night vision goggles feature a built-in IR LED for close-up viewing, binocular vision, close-up/distance focusing, and electronic signal enhancement. The last device sells for about $6000, yet organizations with established bona fides may be able to obtain the instrument as government surplus.

A commercial model of the AN/PVS-5A is sold under the trade name Litton M-909, for approximately $8000 and features an f/1.1 lens providing increased brightness. Resolution is advertised at 32 lines pairs per millimetre.

All the infrared devices listed in this article will allow personnel free movement about the darkroom. Unlike the binocular devices, which allows the use of both hands and unrestricted movement, the monocular devices are either hand-held or mounted on a stand above the work area. When the monocular device is hand-held, the technician is limited to the use of one hand, but has unrestricted mobility. Conversely, when the device is mounted, the user is confined to the work station but has full use of both hands.

Light-sensitive film must be protected from visible light emitted from the scopes to prevent fogging of sensitized materials.

Resolution of the night vision devices vary with the manufacturer. High-resolution electronically intensified devices will allow more detail to be perceived. However, even the best instruments will only allow macroscopic detail to be seen and then only if the subject has contrasting IR signatures. Metallic silver particles which are responsible for the density of the photographic image are excellent reflectors of IR radiation and contrast strongly with the low density areas of the negative.

Each device represented in Figs. 3 through 6 is suitable for use in the darkroom.

Investigators that reside outside of the United States will experience problems in obtaining American manufactured IR inspection devices that use the second generation light amplification plates. Presently, such devices are prohibited from being exported from the United States without a valid export license issued by the Department of Commerce.

An IR flashlight is a good source of portable illumination for the viewing devices. A simple flashlight can be fabricated using a generic brand IR camera filter over the bulb of a common flashlight. Infrared safelight material is expensive and difficult to cut and is therefore not recommended.

The author suggests using a small IR LED wired in series with two 1.5-V alkaline batteries. This IR LED configuration provides ample illumination for use with the intensified goggles and is very inexpensive to construct (Fig. 7).

The short lead of the IR LED is wired to one side of the resistor (82 Ω). The other side is connected to the switch. The switch is wired to the (+) terminal of the 3.0-V power source and finally the (−) terminal of the battery is wired to the long lead of the IR LED.

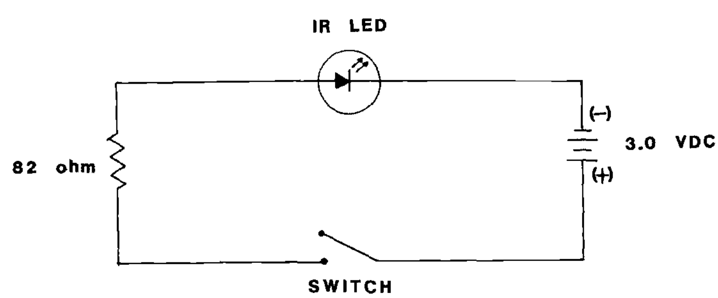

FIG. 7—*Wiring diagram of IR LED flashlight. Infrared LED: Radio Shack TIL906-1, Catalog No. 276-143. Current: 20 mA at 1.3 V. Resistor: 82 Ω, 5%, 1/8 W or larger.*

Even though the device will emit a faint red glow, the flashlight can be safely used at a distance of 1 m without fear of fogging film. Under laboratory conditions, the IR LED radiation source was tested with Kodak Tri-X Pan film. There was no evidence of fogging after 15 min of exposure. Experimenters should run trial photo processes to insure that their "flashlights" do not produce fogging of valuable film.

Experimental Procedures

Each step follows the correct procedure for time/temperature processing recommended by the manufacturer.

Kodak recommends that Tri-X Pan B & W film be processed for 11 min at 68°F in Kodak D-76 Developer (1 : 1). Initial agitation is for the first 30 s upon immersion in the developer solution. Subsequent agitation occurs for 5 s at 30-s intervals. This is the normal method of development.

Under IR safelight conditions and with the use of IR viewers, the film can be processed in a beaker instead of the tank. As always, the solutions are mixed according to the Kodak instructions. When the darkroom is secure to visible light, the technician can load the film on the reel and immediately begin processing.

The author prefers the longest development times and the lowest developer temperature recommended for a given film/developer combination. This procedure allows greater control of the development process.

If 35-mm film is being processed, load the reel with the last exposure towards the center of the reel. Do not cut the leader. You will find several advantages when loading film in this manner. First of all, the leader will remain attached and will be processed. Normally, the leader has been fogged by the time it has been loaded into the camera. When the film is immersed in the developer, the leader will immediately begin to develop. This will be a good indicator of maximum density attained in the development process. Second, the first exposure is near the outside of the reel. As development proceeds, the film can be carefully stripped from the reel and inspected. In most cases, the first exposures will appear within the first 25 cm from the leader. After inspection, the film can be carefully rewound onto the reel.

Recent experiments using the new Kodak T-Max Professional Films indicate that they can be safely processed by IR inspection. Follow the manufacturers recommendations for agitation and developer selection.

Figure 8 simulates processing film by IR inspection. Note that the film has been stripped from the reel for viewing.

The following are guidelines for development under IR safelight conditions:

1. Prepare the developer solution as recommended by the manufacturer for the film selected. Stop bath, fixer, and other solutions should be prepared and brought to temperature for normal processing.
2. Load the film in the normal manner or by the method recommended above. Stainless steel reels are preferable. (Film may be loaded under IR safelight conditions).
3. Place the film in a light-tight container for intermediate storage.
4. Film may be processed, under IR conditions, either in the tank or in a glass beaker. Under IR safelight conditions, immerse the film in the developer solution and slowly agitate the reel, up and down, as well as in the circular motion for the first 30 s. Allow the film to rest and develop. At 30-s intervals, repeat the agitation step for 2 to 5 s.

After 1 min, initial development can be observed. Continue development according to the time and temperature method unless the film is greatly overexposed. In the case of overexposure, the technician may wish to discontinue the development step and terminate processing.

FIG. 8—*Stripping the film from processing reel for subsequent inspection. Note the use of the Litton AN/PVS-5A Nightvision goggles.*

Discussion

Underexposure is the worse situation found in processing film. No matter what developing technique is used, gross underexposure will present a problem to the technician. However, processing the film by IR inspection will allow one to extend the development process beyond the normal time recommended, while visually monitoring the density of the image and base fog. This "push" may produce more useable images on the film. Unfortunately, there is no established formula for extending the processing time or using specialized processing techniques.

Test samples of film exposed at various light levels should be prepared to practice processing the film using IR inspection techniques. During the training sessions, the technician will become familiar with inspecting the samples that have been under- and over-exposed. Remember that the film will appear more developed than it actually is due to the unexposed silver halide crystals in the emulsion. Overdevelopment will increase the base fog and will alter film contrast, while underdevelopment will reduce shadow detail to a minimum. Both extremes will affect resolution.

Summary

New photographic frontiers can be explored by applying high technology to the darkroom. Processing film by IR inspection is not a spectator skill; one must practice loading and developing various films to gain master status in the darkroom. The lab technician will find how fascinating it is to watch a latent image develop normally, and the experience gained will help the technician manipulate the photographic process when it is necessary. The ability to monitor the photographic process from beginning to end is only one use of the IR devices.

For the forensic science laboratory, the benefits of owning the IR equipment extend beyond the darkroom. Questioned document examination, medical observations, and other forensic science applications can be cited as reasons for procuring this valuable instrument.

Acknowledgment

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