Range Commanders Council

OPTICAL SYSTEMS GROUP

DOCUMENT 460-97

COLOR NEGATIVE AND T-MAX FILMS AS STANDARD RANGE OPTICS FILMS

WHITE SANDS MISSILE RANGE
KWAJALEIN MISSILE RANGE
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INTRODUCTION

This report is divided into three parts. The first part contains a brief history of this task and the advantages of Ektapress professional films and the C-41 process over other films and processes. The second part contains the actual testing of the films and the costs associated with Ektapress film. The last section is on the reproduction of Ektapress film and the conclusion of the task.

HISTORY

When this task was proposed in 1993, the only alternative to Eastman Ektachrome cine camera and print films (VNF-1 process) was Eastman color negative films (ECN-2 process). Although the color negative film offered an improved final product over the Ektachrome film, there were problems in maintaining two processes (ECN-2 and ECP-2A) and the limited range of films that were available to the customer.

A third family of films, Kodak Ektapress Gold 100, Plus 400, and Gold 1600 professional films, existed which used the C-41 color negative process. These films offered great versatility from EI 100 to EI 6400 with push processing. The problem was that these films were intended for the still film market and were on an acetate base. A joint effort between Visual Information and Optics Branches at White Sands Missile Range (WSMR), New Mexico, resulted in testing this film on acetate base. The results were successful. The next step of this testing was having Eastman Kodak coat the Gold 1600 on an ESTAR base to allow testing with high-speed optics cameras.

ADVANTAGES

The development procedure for the C-41 process involves a color developer, bleach, and fixer, all of which can be regenerated. Only the stabilizer goes down the drain. The VNF-1 process contains a black and white developer, color developer, accelerator, bleach, and stabilizer, while the ECN-2 process contains bleach, fixer, and stabilizer and that's not counting the chemicals in the ECP-2A print process.

With less chemicals in the C-41 process, the advantages over the VNF-1 and ECN-2/ECP-2A processes are both economical and environmental. Also, less time is needed for chemical mixing and process control. The C-41 process is adaptable to both motion picture and still processing laboratories. In the most extreme case, a single C-41 processor could handle 16, 35, and 70 mm motion picture film and a variety of sizes of still negative film. In designing a new processing facility, the C-41 process should be the main focus. In reality, most government facilities have already invested large sums of money in processing laboratories with the VNF-1 and ECN-2/ECP-2A processes. The Ektapress family of films now becomes a valuable addition to the optics films already in place.

This family of films allows for the data reduction of the optical films combined with the clarity of public relations release prints. The Ektapress Gold 100 film combines medium speed with fine grain and high sharpness. Ektapress Plus 400 and 1600 films, intended for push processing, allow for great photographic conditions under an extremely wide variety of lighting conditions. Ektapress Plus 400 film offers high to very high speed, up to EI 1600 with push processing. Ektapress Plus 1600 film features high to ultra-high speed, up to EI 6400 with push processing. An added advantage to the Ektapress family of films is room temperature storage, ideal when conditions prohibit refrigerated storage.

Although the majority of testing in this report is with the color films, there has also been some testing with black and white films. Kodak T-Max 400 professional film (SO-078 on ESTAR base), a panchromatic black and white negative film, has shown an improvement over Kodak Linograph Shell Burst (LSB) 2476 film. The flexibility and predictability of tone variance over a characteristic curve can be determined by comparing the capabilities of both T-Max (SO-078) and LSB film.

Developed for cinetheodolites cameras, LSB is a red sensitive film with great total contrast yet with little contrast in the shadows if on the extreme density portion of the film. The total tone range of this film is limited to pre-mission setups and, as with this film, has very little practical latitude. The WSMR has successfully used LSB for several years, but with the unpredictability of mission requirements and conditions totally out of the operator's control, the photo laboratory has been requested to force process the development of LSB to compensate for exposure problems.

Developer contrast improvements were minimal with one stop forced processing and decreased shadows in the toe area with increase development. The practicality of forced processing on LSB with its limited latitude capability only marginally increased with the use of D-96 black and white developer from its common developer D-19. As evident on a Hurter and Driffield (H&D) plot with the increase of development, the base plus fog density raised with the shoulder region causing poor highlight tone separations in our test prints. By forced process of more than one stop, tone separation in the shadow or highlight of the print decreases as does the main portion of the straight line contrast.

As mentioned earlier with the forced processing of LSB, the overexposure normally would cause the print to be flat and low in contrast, but not in the case with T-Max (SO-078) film. The more the development, the higher the gamma, the greater the contrast of the negative because of development. This film features the Kodak T-Grain emulsion which is an extremely fine grain with high resolving power and increases its latitude capabilities with respect to straight-line densities. Major deviations in time constraints or lighting requirements are recoverable with forced developer processing. As determined by sensitometry, an H&D plot indicates an increase of straight-line contrast and an average tone spread. As a commercially developed film, T-Max range of latitude is basically more predictable and more forgiving. The T-Max family of professional films includes the following ranges:

TYPE	EL RANGE WITH FORCED PROCESS
T-Max 100	100 to 800
T-Max 400	400 to 3200
T-Max P3200	3200 to 25,600

FILM TESTING

White Sands Missile Range has been using VNF (Video News Film) since 1986. It has met the needs and expectations of testing numerous missile and aircraft systems over the years. Recently though, with newer systems being tested and with changing customer requirements, WSMR has been investigating film alternatives.

The more recent defense system requirements have been to provide data on higher altitude miss distance profiles and data on missions occurring at times when the light levels are low. A typical mission is either a missile-versus-missile scenario or a missile-versus-aircraft scenario. Reduced light levels occur based on the time of day of a missile firing or a camera with a large focal length lens (100, 180, or 200 inches) that is used to capture data on a high altitude missile. The VNF film (400 ASA) has done well in the past, but the reduced light requirements have prompted further looks at other films.

Kodak prepared a color-negative film on an acetate base with an ASA of 1600. It was requested that a test batch be established on an ESTAR base to better accommodate WSMR's motion picture high speeds (120 - 2000 fps). Kodak prepared a batch, known as QX805, and cut it into 35 mm by 1200-foot and 70 mm by 1200-foot rolls. The film has been tested since its receipt in January 1996 on several missions, and further investigation of side-by-side VNF verses color-negative film comparisons are anticipated. The film has been run on the Patriot, Stinger, Army Tactical Missile System (ATACMS), Delta Clipper (DC-XA), and Black Brant missions.

The best side-by-side comparison is that produced on the Black Brant mission. Two fixed cameras were placed side by side and loaded with the VNF film in one and the color negative film in the other. The frame rate of the cameras was 120 fps. The missile was fired from a vertical launcher at 11:30 at night with a full moon. The missile was lit up by the flames it produced. The VNF film was push processed 2 stops to bring it up to an equivalent ASA of 1600, and the color-negative film was processed at its normal ASA of 1600. The comparison of the film shows more detail in the color-negative film as shown by the clearer, well-defined missile plume and the definition of the rail launcher bars. The results might be more drastic if the color-negative film were push processed 1 or 2 stops, but current processing equipment limits roll film to normal processing at this time. In essence, under lower light conditions, the color-negative shows promise of being able to provide an image where VNF might not be able to. In some instances, the film was somewhat brittle. The film may require different handling techniques than those currently in use. The recommended humidity of (30-50 percent), temperature of $\leq 50°$ for storage, and no prolonged usage at 110-120° are factors for WSMR based on the desert environment.

In general, the ESTAR base film is stronger than the acetate base film as shown in the table provided by Kodak:

	ESTAR	TRIACETATE
Yield Strength (Tear)	13,800 psi	11,800 psi
Tensile Strength (Break)	25,000 psi	15,500 psi
Tensile Elongation (Stretch)	110%	35%
Toughness	22,000 lb./in	4,500 lb./in

Additional testing has been performed with still photography images. Controlled photographs were taken between sunrise at 0600 and 2 hours after sunrise at 0800 to determine the effects of low light levels and increasing light levels on an object. The color negative film shows an increased exposure latitude that the VNF film does not display. The latitude of color negative film heightens the ability to produce an image and required data.

As a side item, limited comparison testing has been done on two black and white films: SO078 and LSB. The preliminary response on the quality of the SO078 is that it provides finer contrast information over the LSB.

COSTS

The cost of the color negative film is dependent on the quantities and types (16, 35, and 70 mm) of film cut from the large sheet of film purchased. The cost of the raw film is approximately 1.5 times that of the VNF film. The cost would be $2800 for a roll of 70 mm film, $1400 for a roll of 35 mm film, and $125 for a roll of 16 mm film. Typically, the 70 and 35 mm films are used in 1200-foot rolls and the 16 mm is used in 450-foot rolls. Film processing costs are the same for VNF and color negative film. As more missions become available, the film will be tested further to investigate its quality when used for low light level conditions.

FILM REPRODUCTION

White Sands Missile Range Optics Branch has been testing QX805, an ESTAR based film, primarily developed for cine motion picture capabilities at WSMR. The QX805 is based on Kodak's popular Ektapress Gold film series color negative film 100 to 1600 ASA. The on going tests by the range have tasked the VISS IM Reproduction Section to reproduce and transfer this type of film to video. The following steps have been developed by the Reproduction Section since the onset of the test film QX805.

70 mm QX805 ASA 1600

- For film to a copy negative. This film was printed on 5399 Eastman Kodak print stock. The 6700 C Bell & Howell Contact Printer we were also able to use Eastman Kodak 2253 ESTAR base camera film.

- For film to a positive print. Eastman Kodak Vericolor 5072 slide film was used also making use of the 6700 C Bell & Howell Contact Printer.

- For film to 16 mm format transfer to video. This test film was printed on Eastman Kodak 7399 VNF print stock which produced a negative to transfer to video on the Telecine Film Transferring System. Both the Pioneer Trebes and Photosonics Optical Printer can be used to reduce this film and accomplish this task.

35 mm QX805 ASA 1600

- For film to copy negative. The test film was printed on 5399 Eastman Kodak print stock or Eastman Kodak 2253 ESTAR base camera film. The 6200 C Bell & Howell Contact Printer was used for this transfer.

- To transfer QX805 film to positive print. Eastman Kodak Vericolor 5072 slide film was used with the 6200 C Bell & Howell Contact Printer.

- In transferring this film directly to video. The ADS 11 Rank-Cintel Transferring System was used to transfer directly to video in a positive image.

- In reducing this film to 16 mm format in negative image. The Bell & Howell Research Printer and Oxberry Optical Printer was used.

In reproducing this test film, the contact and optical printers varied on voltage for lamp requirements. Filtration for color vanes (blue, green, and red) and trim settings varied with different emulation films. The variation in values are determined by close testing in motion picture timer and film processing. The cost for printing and transferring this film is the same as reversal film.

CONCLUSION

In an ideal world, the Ektapress family of films would easily replace the Eastman color negative films and Eastman Ektachrome films. They offer a great deal of versatility, low processing cost, and nearly perfect environmental conditions. Realistically, with decreasing film usage, shortage of money, and expensive processing laboratories already in place, these films become valuable additions for optical systems.