MANFRED DUDDEK*
Wild Heerbrugg, Ltd.
Heerbrugg, Switzerland

Practical Experiences with Aerial Color Photography

All contributing factors should be thoroughly investigated in order to obtain maximum information

See Front Cover

ABSTRACT: *Theoretical investigations and practical tests must be made prior to any productive employment of aerial color films. Such investigations and tests are, however, costly and time-consuming. Wild Heerbrugg Ltd., together with the Swiss Federal Survey Department, therefore undertook to conduct these investigations and practical tests in order to give guidance to the users of Wild cameras who are interested in aerial color photography. The results of the flight tests carried out during the period 1962–1965 have proved that the 6-inch Aviogon and 6-inch Universal Aviogon lenses are well suited for color photography. However, there are influences from the lens and from the filter which must be taken into consideration. The procedure which finally brought consistently good results with different types of Kodak color films is outlined.*

INTRODUCTION

IN THE COURSE OF the past few years, the aerial color photograph has developed into a new basic medium for photointerpretation and photogrammetry. In comparison to the black-and-white photograph, it is distinguished by its much greater information content.

In spite of the obvious advantages offered by aerial color photography, it is still only rather hesitantly accepted for practical application, because:

- Exposure and processing of color films are more difficult,
- The cost of color materials is higher in comparison to corresponding black-and-white materials, and
- The requirements in terms of time and instruments are greater.

The aim of our experiments was to become acquainted with the various problems of exposure and processing of color films.

By and large, the problems encountered in processing color films are not new; they had long been discussed in scientific publications in connection with black-and-white photography, where the individual components, however, do not have the same immediate influence on the quality of the black-and-white end product as they have in color processing.

Experiments were carried out with the following types of film:

Kodak Ektachrome Aero Film, Type 8442 (high contrast)
Kodak Special Ektacolor Aerial Film, Type SO-276
Kodak Ektachrome Infrared Aero Film, Type 8443 (false color)

All films had a length of 75 ft. (25 m.) and were developed in a conventional rewind developing machine.

In the subsequent stage of processing, the following photographic positive materials were investigated, and partly also used for our own consumption or for contract jobs:

Kodak Ektacolor Professional Paper for prints from Special Ektacolor Aerial Film, Type SO-276 (negatives), and

Cibachrome-Print for prints from Kodak Ektachrome Aero Film, Type 8442, or Kodak Ektachrome Infrared Aero Film, Type 8443 (both reversal positives).

* Presented at the Annual Convention of the American Society of Photogrammetry in Washington, D. C., March 1967 by Mr. K. E. Reynolds, Wild Heerbrugg Instruments, Inc., Farmingdale, N. Y.

The pictures were taken with the following cameras and lenses:

> Wild RC5, Wild RC8, with 6-inch Universal Aviogon and 6-inch Aviogon, and Wild RC9 with 88.5 mm. Super Aviogon.

For a number of experiments, two cameras were installed in the aircraft to take simultaneous photographs with different types of film.

The true aim of our experiments was to obtain good results even under a variety of photographic conditions. Naturally it is more difficult to achieve this aim with the Kodak Ektachrome Aero Film, Type 8442 (high contrast) than for example with a negative film because, by virtue of its high contrast the Ektachrome Aero Film, Type 8442, it must be regarded as a special film for photography taken from heights of over 4,000 meters. For practical considerations, we had to choose a flying height of approximately 1,500 meters above ground; at such heights, the film is relatively difficult to control in exposure and also in processing.

On the other hand this was beneficial because greater care had to be exercised in exposure and processing. In the subsequent use of *softer* materials with more generous processing tolerances, the experiences gathered with type 8442 could be immediately applied for good results. The exposure and processing stages should harmonize in such a way that, when viewed over a light source having a color temperature of approximately 3,800 K, the color transparencies should yield a natural color rendition.

As far as this visual method of judgment is concerned, it must be kept in mind that a homogeneous color rendition cannot be expected, since the distribution of illuminance within the area of the picture varies greatly. In addition to the intensity of illumination, the color temperature also varies with the field angle. It should also be mentioned that the physiological perception of colors does not permit a positive statement on the physical properties of the object colors and their registration on the film.

In spite of these limitations, visual appraisal is critical enough for all practical purposes to distinguish the good results from those not so good. We are able to discern a dominant color cast and remedy it through the use of appropriate filters, or through other measures, during exposure or processing. This statement seems to be of special importance. It is obvious that absolute color fidelity between ground detail and its image on film is not possible and that we must contend ourselves with a *falsified* color differentiation. If however any color dominates in the photograph in the form of an overall color cast originating either in the exposure or in the development stage, then a part of the expected information is lost because of a generally worsened color differentiation in the entire spectral photometric range of the film concerned. In black-and-white photography, a *color cast* manifests itself only as a shift within the gray scale and is therefore scarcely annoying.

To extract a maximum of information from a color aerial photograph, it is important to investigate the influence of all factors contributing to the achievement of the desired maximum. However, only those factors are listed or discussed here that have proved to be problematic in the course of the practical experiments and that must therefore be given special consideration in the exposure and processing stages.

The Taking Lens

Here we are primarily interested in the general suitability of a certain lens type for color photography, in the light distribution in the plane of the picture, and in the special transmission of the lens. The 6-inch Aviogon and the 88.5 mm. Super Aviogon are chromatically corrected for the spectral range from 450 to 650 millimicrons, with the center of gravity at 588 millimicrons (*d*-line), i.e. the chromatic correction range is practically coincident with the spectral sensitivity range of conventional color film emulsions.

The 6-inch Universal Aviogon differs from these lens types in its chromatic correction range (Figure 1): maintaining the same center of gravity, the chromatic correction was extended towards the long-wave infrared radiation. The 6-inch Universal Aviogon is chromatically corrected for the range from 450 millimicrons to 850 millimicrons. It is of interest that for this remarkable progress in the development of high-performance lenses, no concessions were made as to the image quality of the 6-inch Aviogon with respect to resolving power, distortion, and light distribution. The use of the 6-inch Universal Aviogon lens in color photography is indicated in all those cases where color films are used whose sensitivity is extended considerably into the infrared range—for example the Kodak Ektachrome Infrared Aero Film (false color) or the Spectrozonal Film widely used in the Soviet Union.

The light distribution in the plane of the

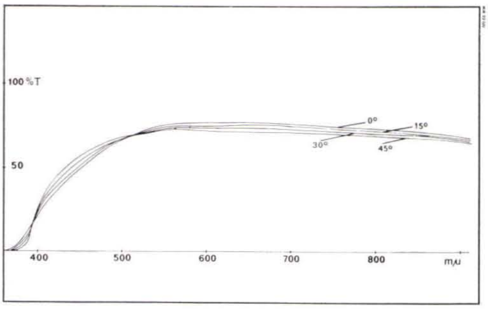

FIG. 1. Spectral transmission of the 6-inch Aviogon and the 6-inch Universal Aviogon lenses.

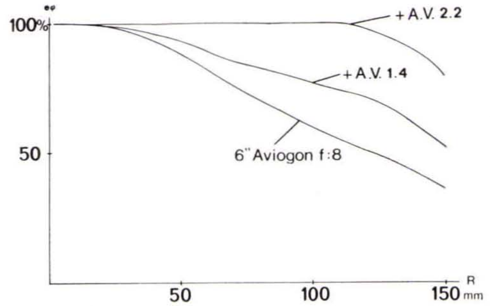

FIG. 3. Relative illumination in the plane of the negative for the 6-inch Aviogon $f/8$.

picture of the 6-inch Aviogon and Universal Aviogon lenses is shown in Figures 2 and 3.

The light fall-off, unavoidable in wide-angle and super-wide-angle lenses, is alleviated by a graded-density layer on the filter. This results in a shading of the central portion of the picture in such a way that the exposed photographic emulsion appears evenly backened or colored. With black-and-white emulsions of normal gradation, brightness differences of up to 40 per cent can be tolerated. In color photography, the compensation of the fall-off in illumination is of greater significance because color emulsions have little exposure latitude.

The required central density of the graded-density filter depends on the flying height and on the presence of haze between ground and camera. In Figure 7, the maximum density of the graded-density filter is represented as a function of flying height and horizontal visual range at ground level.

In this connection it is of paramount importance to maintain strict neutrality in the spectral transmission of the graded-density layer, independent of its varying density. Figure 4 shows the spectral transmission of the graded-density filter A.V. 2.2×(T min. 45 per cent). In addition, the spectral transmission of the taking lens is of interest, as shown in Figure 1 for the 6-inch Aviogon and 6-inch Universal Aviogon. For color photography, it is of consequence that the lenses have a slight yellow filter effect. This yellow filter effect, caused by the reduced transmission in the short-wave range, is taken into account during exposure through the choice of appropriate color correction filters.

Figure 1 also shows the degree of transmission of the lenses in the vicinity of the optical axis. It amounts to approximately 0.65 for the spectral range from 400 millimicrons to 650 millimicrons, and approximately 0.78 for the range from 500 millimicrons to 850 millimicrons. The degree of transmission is important for the determination of the effective film speed. Between the 6-inch Aviogon and the 6-inch Universal Aviogon there is a slight difference in degree of transmission insofar as the gradient of the curve in the short-wave range is somewhat steeper, and the maximum degree of transmission is some 5 per cent higher for the 6-inch Universal Aviogon than for the 6-inch Aviogon. For all practical purposes, these differences are insignificant.

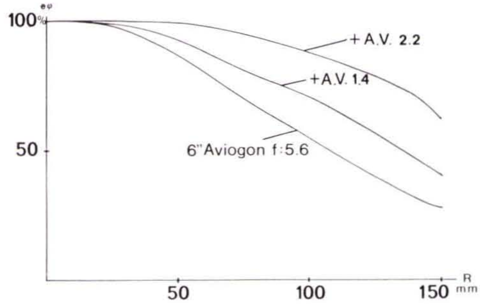

FIG. 2. Relative illumination in the plane of the negative for the 6-inch Aviogon, $f/5.6$.

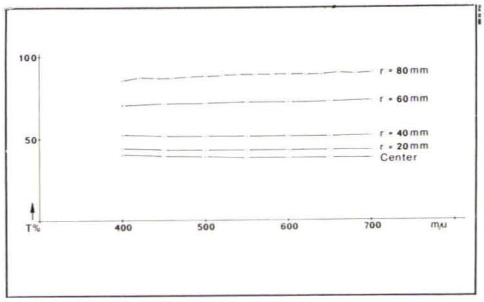

FIG. 4. Spectral transmission of the anti-vignetting coating 2.2×.

The degree of efficiency of the lens shutters is over 80 per cent. The slight loss of light from this source can therefore be neglected.

A few remarks should be made relative to the anti-reflection coating of the lens. In design and production of high-performance lenses, special attention is paid to the reduction of reflections by coating the lens surfaces. The tolerance for the absorption range of the coating layers is determined to a certain degree by the properties of the photographic emulsion used. This range had been greater with the old Aviogons, as they were mainly used with black-and-white emulsions where wave lengths shorter than 450 millimicrons were absorbed by a minus-blue (yellow) filter anyway. Color emulsions are considerably more delicate in this respect. They are capable of registering minute, if practically insignificant reflections. In taking photographs on contrasty reversal color film it can therefore happen that in isolated instances, depending on the spectral composition of the effective radiation, a mildly bluish diaphragm reflection becomes visible in the center of the image. As this spot is aperture dependent, it can be alleviated by using the largest possible aperture and controlling the exposure with the shutter speed. For the 6-inch Universal Aviogon the antireflection coating specifications were tightened to such a degree that this phenomenon is no longer encountered.

The Atmosphere

Correct estimation of the changing atmospheric properties plays a very great role in color photography. As a standard for visual judging of atmospheric influences, the horizontal visual range at ground level in the area to be photographed may be used.

Our filter values and exposure corrections (see Figure 6) are referred to four steps of the simplified International Visibility Scale. The proportion of haze in the Optical Standard Atmosphere is therefore according to horizontal visual range:

Step 6, visibility 4 to 10 km.—moderate haze
Step 7, visibility 10 to 20 km.—light haze
Step 8, visibility 20 to 50 km.—nearly clear
Step 9, visibility over 50 km.—clear

Two definitions are appropriate here:

(1) The *horizontal visual range* is the distance at which objects are just recognizable (minimum over an angle of 180°).
(2) The *Optical Standard Atmosphere* is defined as the one in which the scattering particles are the same at all altitudes but in which the relative number of particles per unit of volume decreases regularly with the altitude.

Determination of Correct Exposure

Although in black-and-white aerial photography the purely visual method of determination of the (more or less) correct exposure is still used in many places, this method is not permissible in color photography. The exposure latitude of color film emulsions is too small and they require therefore an exact determination of exposure. Kodak quotes exposure indexes (E.I.) for the various film types, which are meaningful only in connection with the Kodak Aerial Exposure Computer. There is no direct relation between these exposure indexes and, for example, the ASA system.

With the proper use of the Aerial Exposure Computer, the correct exposure can be obtained, provided subject brightness and atmospheric haze are correctly estimated and the exposure index for the film is reduced by the filter factor (graded-density coating and perhaps color correction filter) and the transmission factor of the lens. Here is an example:

Film—Kodak Ektachrome Aero Film, Type 8442, E.I.	25
Filter with graded-density coating	2.2×
Transmission factor of the 6-inch Universal Aviogon	1.4×
Filter factor times lens factor	3×
Effective E.I.	8

An alternative solution to the use of a Kodak Aerial Exposure Computer is the use of a conventional lightmeter. In our experiments we have determined the exposure with a Grossen *Lunasix*. The *Lunasix* is a locking-needle CdS lightmeter with an acceptance angle of 30°.

When using a lightmeter, the following rule must be kept in mind: if the measurements are taken during the approach phase of the flight, the terrain reflectance within the measuring angle of 30° must correspond approximately to the average ground reflectance in the actual area to be photographed. An integrating measurement over a certain field, in our case 30°, may be used as an absolute value for the setting of diaphragm and shutter speed only if illumination and reflectance in the area where the exposure was measured corresponds to conditions in the area to be photographed.

If strong variations occur in the area to be photographed, such as dark forest areas in a predominance of farm land, the diaphragm must be opened one stop for the forest areas if the diaphragm setting had been determined from a measurement over farm land. In our own flights, through continual assess-

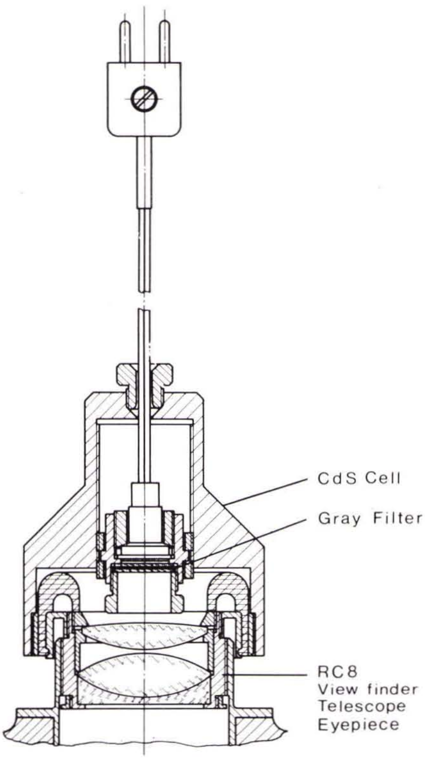

FIG. 5. Placement of the CdS cell in the exit pupil of the RC8 viewfinder telescope.

ment of ground reflectance in the viewfinder telescope, comparison with the area where the measurements were taken, and corresponding adjustment of the diaphragm, we have obtained perfectly exposed photographs although in one and the same flight strip, areas of predominantly bright rock, dark forests, and snow fields were depicted.

An even more authoritative measurement of exposure was achieved with the remote-cell arrangement shown in Figure 5, where the Lunasix's CdS meter cell is positioned at the exit pupil of the RC8 viewfinder telescope. Through this arrangement a measurement is obtained which is integrated over the entire field angle of 95°. By placing appropriate gray filters in front of the cell it is possible to make allowance for the transmission factor of the viewfinder telescope and to calibrate the meter reading to a standard value.

ASA Settings

For the film types listed below, the following effective ASA lightmeter settings were used:

Kodak Ektachrome Aero Film, Type 8442	125 ASA
Kodak Special Ektacolor Aerial Film, Type SO-276	50 ASA
Kodak Ektachrome Infrared Aero Film, Type 8443	65 ASA

These ASA settings were used for all photographs taken with a 6-inch Aviogon with 2.2× graded-density sandwich filter. Atmospheric conditions corresponded to a horizontal visual range of 8, sometimes 9.

If a 1.4× graded-density filter is used for the 6-inch Aviogon lenses, the ASA settings must be *increased* by 30 per cent. For photography with the RC9, 88.5 mm. Super Aviogon, and 4.4× graded-density filter, the ASA settings must be *reduced* by 30 per cent. With diminishing visual range, the exposure time reductions shown in Figure 6 must be applied.

For the Kodak Ektachrome Infrared Aero Film, Type 8443, the factor of the prescribed Wratten filter No. 12 (500 millimicrons) is already included in the ASA value. The ASA values given here can be adopted without change only if the First Developer stage corresponds in time, agitation, and temperature exactly to the data given on page 1123 for the film type concerned.

Filter

In aerial color photography, the use of filters in the form of thin gelatin sheets is still essential in the exposure of reversal color films. For the positioning of these gelatin sheets in front of the lens, special sandwich filter holders are available for the 6-inch Universal Aviogon, 6-inch Aviogon, and 88.5 mm. Super Aviogon lenses. They consist of a mount and two optically flat glass plates (Figure 7) between which the cut-to-size

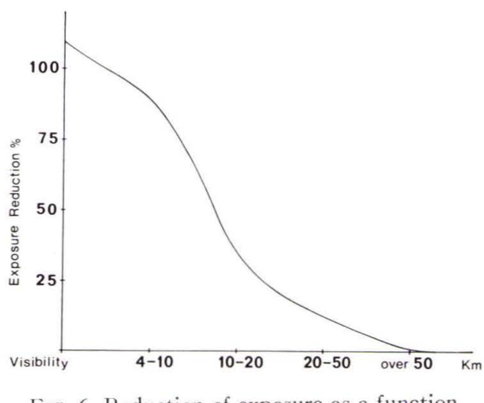

FIG. 6. Reduction of exposure as a function of horizontal visibility.

gelatin sheets are "sandwiched." The glass surface next to the lens has a neutral graded-density coating (see Figure 4). For economical and manufacturing reasons it is not possible to replace the gelatin filters by solid glass filters, because the emulsion filters needed (for example, for the Ektachrome Type 8442 films) change from batch to batch. Moreover, the glass manufacturing industry cannot provide mass-colored glasses of the fine differentiation in spectral transmission required for color compensating (CC) filters (see Figures 8 and 9).

The influence of the gelatin sheet between the two glass plates on resolving power and distortion is insignificant as long as the gelatin sheet is plane. Unfortunately, this planeness is not always assured. If the level of humidity in the gelatin undergoes rapid changes, the sheet tends to shrink and warp. The consequence of this is a zonal deterioration of the resolving power. This phenomenon is encountered relatively often because with falling temperatures (increasing altitude), the relative humidity increases.

After numerous laboratory experiments, we arrived at the following simple solution of this problem. After placing the gelatin sheet (or sheets) between the two glass plates, the edge of the pair of plates is sealed with a single thickness of Scotch Magic Transparent Tape No. 810, with only a short overlap of the tape ends (with more than one layer of tape, the "filter sandwich" would not fit the mount anymore). If the relative humidity on the ground is already more than 70 per cent, it is advisable to reduce the humidity content of the gelatin sheet by means of a hair-dryer before the sheet is sealed in. In those cases where no gelatin filter is needed for emulsion or color correction (e.g. with negative film) a

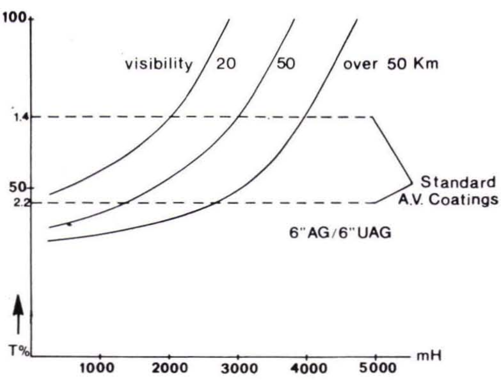

FIG. 7. Minimum transmission of anti-vignetting coating as a function of flying height above ground and horizontal visibility.

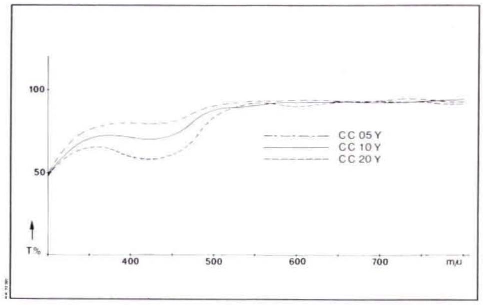

FIG. 8. Spectral transmission of Kodak Wratten CC yellow filters.

solid filter with corresponding graded-density layer should be used.

Reversal Color Films

KODAK EKTACHROME AERO FILM, TYPE 8442

The color balance of this film, nominally 5,500 K, may vary from emulsion to emulsion. For this reason an Emulsion Filter (EF) is required, Kodak encloses such a filter in the form of a gelatin sheet with every roll of film. However, the size of this filter (5 in.×5 in.; 12.7 cm.×12.7 cm.) is too small for use with the 6-inch Aviogon and 88.5 mm. Super Avigon lenses. When ordering Ektachrome Aero Film, an emulsion filter of the size $9\frac{1}{2}$ in. ×$9\frac{1}{2}$ in. (240 mm.×240 mm.) must therefore also be ordered to be delivered with the film. The user himself must cut it to fit the circular sandwich filter.

The Haze Filter (HF) enclosed with every roll of film is spectrally unsuited for use with any Aviogon lens and should be discarded; the filter effect of the Aviogon lenses (see Figure 1) is already greater than that of the HF filters.

For the dependence on flying height and atmospheric conditions, additional CC filters (color compensation filter) in the form of gelatin sheets were used by us, as shown in

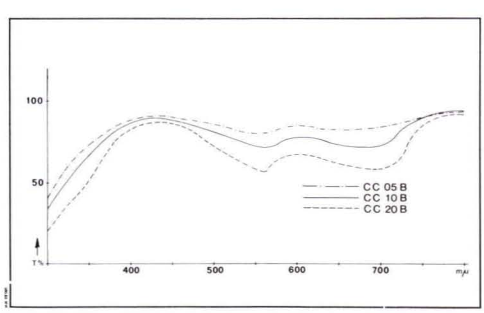

FIG. 9. Spectral transmission curves of Kodak Wratten CC blue filters.

TABLE 1. DEPENDENCE OF THE TYPE OF FILTER ON FLYING HEIGHT AND ATMOSPHERIC CONDITIONS

Approx. Flying Height above ground in		*Horizontal Visual Range on the ground*			
m.	*ft.*	*4–10 km. (2½–6 mi.)*	*10–20 km. (6–12 mi.)*	*20–50 km. (12–30 mi.)*	*Over 50 km. (Over 30 mi.)*
600–1,000	2,000– 3,500	05 Y	no filter	05 B	10 B
1,000–1,500	3,500– 5,000	10 Y	05 Y	no filter	05 B
1,500–2,500	5,000– 8,000		10 Y	05 Y	no filter
2,500–4,000	8,000–13,000			10 Y	05 Y

Table 1. In photography over cities or industrial regions, filters of the next lower visual range column are used to compensate for the additional haze covering these areas. No increase of exposure time is necessary with the use of any of these filters.

Development. The 75-ft. films were developed to Kodak specifications with the original Kodak E3 chemicals (6-gallon size) in a conventional rewind developing machine, at a film velocity of 30 m. (100 ft.) per minute. The only deviation was that the First Developer time was extended from the Kodak-specified 10 minutes to an actual time of 12 minutes at 75°F±½F (24°C±½°C). The films were dried in a radial-blower film dryer with unheated air.

KODAK EKTACHROME INFRARED AERO FILM, TYPE 8443 (FALSE COLOR)

In contrast to conventional color film, whose three layers are sensitive to blue, green, and red, the three layers of this film are sensitive to green, red and infrared. This film, too, varies in its color balance from one emulsion batch to the other and the remarks on emulsion filters in the preceding chapter apply here also. As all three layers of this film are blue-sensitive to a certain extent, it must always be used with a Wratten filter No. 12 (gelatin filter) which absorbs radiation under 500 millimicrons. Development (E3 Process) is the same as for Kodak Ektachrome Aero Film, Type 8442.

Here is an additional remark concerning the *E3 Process.* Extending the time in the First Developer by 50 per cent results in a speed increase of 66 per cent with a simultaneous increase of contrast and a slight color shift. The direction of the color shift must be determined empirically.

A color shift of up to 10 Wratten filter density points from one developing cycle to the other may have occurred in spite of scrupulous adherence to the specifications of the developing process. The cause for this may be found in the acidity and ionic heavy-metal content (iron, chromium, etc.). To reduce these influences it is recommendable to keep at least the pH level of the water constant.

COLOR NEGATIVE FILM

KODAK SPECIAL EKTACOLOR AERIAL FILM, TYPE SO-276

In comparison to color reversal film, color negative film has these advantages:

The required filtering to achieve the correct color balance takes place in the laboratory when diapositives and paper prints are made, not during exposure,
Developing is not so critical, and
Exposure latitude (±1½ stops) is greater.

In addition to the sandwich filter or solid glass filter with a 2.2× or 1.4× graded-density layer, no other filter is required.

Developing. The 75-ft. films were developed according to Kodak specifications with the original Kodak C22 chemicals (6-gallon size) in a conventional rewind developing machine, with a film velocity of 30 m. (100 ft.) per minute. The First Developer stage was timed at 16 minutes at 75°F±½°F (24°C±½°C). The film was dried in a radial-blower film dryer with unheated air.

Extending the C22 First Developer stage by 50 per cent results in a film speed increase of approximately 40 per cent, combined with a harder gradation. Considerably greater color density and steeper gradation is obtained if the film is first developed, fixed, and treated in a special bleach bath before it is processed exactly to specifications in Kodak C22 chemicals.

For those who want to obtain negatives without sacrificing the advantages offered by color reversal film (sensitivity, contrast), Kodak recommends the SO-151 or SO-282 film types. These are reversal color films which are developed into negatives in a modified C22 developer. This procedure yields more contrasty negatives which differ from

FIG. 10. Sample black-and-white photograph, 1:10,000, $f=6$ inches. Compare with the photograph on the Front Cover which is of the same area taken on Kodak Ektachrome Aero Film, Type 8442, from a Cibachrome print (direct positive process). (Courtesy CIBA Photochemical Ltd., Basel, Switzerland.)

Ektacolor negatives by the fact that they do not have a masking filter. The nonexistent masking filter changes the basic filtering in the printing process.

METRICAL STABILITY OF COLOR FILM EMULSION

The three films used in this investigation have a triacetate base. In order of magnitude, regular film shrinkage is equal to that of black-and-white emulsions on Estar or Cronar base, sometimes even less. This property of the color film emulsion is of interest mainly for metrical photogrammetry and can perhaps be explained with the chemical influence of the stabilizer bath.

In the stabilizing stage of the processing routine, the dye molecules bind with the gelatin molecules, and the gelatin hardens. Thereby the humidity content of the film is reduced to one-third of the humidity content of a black-and-white emulsion just before drying.

PRINTS FROM POSITIVE TRANSPARENCIES

In photogrammetry, positive color transparencies can be used directly as the basic medium in the compilation instrument. To produce prints from positive color transparencies, too possibilities exist:

Printing an inter-negative from the transparency; from the internegative prints are made, for example on Kodak Ektacolor Print Film, or

The direct positive process.

The process involving the use of an *inter-negative* is very costly and is hardly of much interest for photo interpretation or photogrammetry.

CIBACHROME-PRINT

The Cibachrome-Print material is based on the silver-dye bleach process and represents a *direct positive* process; this means that a positive image is obtained from a positive original. In contrast to the conventional photographic color process based on chromogenous development, in the silver-dye bleach process azo dyes of great purity and lightfastness are embedded in the three layers together with approximately sensitized halogenous silver.

Prints made from various Kodak Ektachrome Aero Film Type 8442 and Type 8443 transparencies were made in the color laboratories of CIBA Photochemical Ltd. on Cibachrome-Print material (see Figure 10 and the Front Cover) and have shown very good properties. Remarkable are the brilliance of the colors, the color differentiation and the resolving power (approximately 50 lines per mm., contrast 1,000:1, roughly corresponding to the resolving power of a black-and-white bromide paper), and especially the lightfastness of Cibachrome-Print which is about equivalent to that of good textile dyes.

Prints from Color Negatives

Color prints from color negatives can be produced relatively fast in moderately well-equipped photographic laboratories. If the exposed Kodak Ekachrome paper is processed in a Kodak Rapid Color Processor at 100°F (38.5°C), the entire processing time is only 7 minutes. This procedure is excellently suited for the production of prints in small quantities. *Color transparencies on glass or film, black-and-white diapositives, and black-and-white prints can also be produced from color negatives.*

From the examples shown in Figure 10 and on the Front Cover it can be seen that information in the color picture is better differentiated than in the black-and-white picture. The color negative offers wider latitude and greater simplicity in further processing than the transparency. The decision whether the color negative or the color transparency is to be preferred depends of course on the purpose for which the pictures are taken.

Bibliography

G. C. Brock, "Physical Aspects of Air Photography," Longmanns Green, London, 1952.

Seibert Q. Duntley, "The Reduction of Apparent Contrast by the Atmosphere," *J. Opt. Soc. Am.*, 38, No. 2, Feb. 1948.

Seibert Q. Duntley, "The Visibility of Distant Objects," *J. Opt. Soc. Am.*, 38, No. 3, March 1948.

E. O. Hulburt, "Optics of Atmospheric Haze," *J. Opt. Soc. Am.*, 31, No. 7, July 1941.

H. Kasper, "Einige Betrachtungen zur Photogrammetrischen Aufnahmeoptik," C. F. Baeschlin, Festschrift, Verlag Orell Füssli, Zürich. 1951.

A. Meyer, "Das Silberbleich-Verfahren und seine Anwendung in der Farbphotographie," *Chimia* 18 (1964), B98–399.

L. Mullins, "Some Important Characteristics of Photographic Materials for Air Photographs," *Photogrammetric Record*, Vol. V, No. 28, October 1966.

K. Schwidefsky, "Grundriss der Photogrammetrie," 6/1963, B. G. Teubner, Stuttgart.

L. W. Swanson, "Aerial Photography and Photogrammetry in the Coast and Geodetic Survey," Photogrammetric Engineering, 1964, 30 (5).

Forum

A break for authors of technical articles will begin with the January 1968 issue: each author will receive 100 complimentary reprints (see page 1181). So that the Society will not sustain monetary loss from this new practice, higher rates will accordingly be charged for reprint orders in excess of 100, and authors will no longer receive five free copies of the journal. This new system seems to be more in line with the practice of other journals and the prices for large reprint orders will still be at nominal commercial rates. As in the former practice, the Society seeks only to "break even" in its overall reprint program.

* * *

Mr. Zdenak Kalensky, a student at the University of New Brunswick and a native of Czechoslovakia, has volunteered to assist the Editor in preparing "Articles in Other Photogrammetric Journals" (page 1191). Needless to say, the various languages pose a difficult problem for the Editor who has used some rather "free" translations in the past. The Eastern languages have been especially troublesome. Thanks to the offer of Mr. Kalensky, we look forward to better translations, more timely items, and a more thorough coverage of our Eastern photogrammetrists.

* * *

As announced earlier, a separate listing of the abstracts of the technical articles was discontinued after the April 1967 issue. Instead, the abstracts are printed in the Spanish language. The Society is indebted to the Cartographic School of the Inter American Geodetic Survey which is located in the Canal Zone. Due to the added time involved in translation and correspondence, it has been necessary, however, to publish only the abstracts of the *previous* issue.