APU NO.2

EVALUATION OF AERIAL FILM PROCESSING

THE REWIND METHOD VERSUS CONTINUOUS PROCESSING

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AIR PHOTO UNIT

SURVEYS & MAPPING BRANCH

DEPT. OF ENERGY, MINES & RESOURCES

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The Rewind Method Versus Continuous Processing

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ABSTRACT

It has always been known that aerial film processed in rewind processing equipment received more development in the middle of the roll than at either end. However, some other peculiarities were indicated when we tried to explain some rather unusual defects found on rolls in our vault. This series of tests was designed to illustrate what actual patterns were formed by rewind processing and also to evaluate a modern continuous processor. The use of the continuous processor also provided a control function in that it eliminated the possibility of patterns produced in the rewind processing being interpreted as the result of uneven emulsion coating in the manufacture of the film. The results obtained were unexpected in that the variation in the degree of development across the width of the film far exceeds that found along the length of the roll, and is so pronounced that the usefulness of the rewind method of processing 9½ inch rolls must be seriously questioned.

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1. Introduction

Over the years a great deal of time, money and effort has been expended in an effort to improve the quality, or information yielding component of aerial photography - The key is the quality of the negative produced as it represents the sum total of the performance of the whole system involved - Most attention has been given to the improvement in emulsions, film bases, lens design and to a lesser degree, camera mounts. However, little attention has been given to one phase of the whole operation which plays a most vital part in determining the quality of the resulting negative, that is the method of processing the roll of film. This paper is meant to provide detailed information as to what happens to a roll of aerial film when it is processed in the two most generally used methods, that is, the rewind method and the continuous processor. The film and chemicals used are incidental and do not alter the basic patterns obtained, as is demonstrated by the tests.

Those involved with the processing of aerial films have always had some general ideas as to what happens with respect to the variation in development throughout the roll, when processing 9½ inch aerial film by the rewind method.

This method has been in general use since the beginning of aerial photography and I have never been aware of the pattern illustrated by these tests. While preparing information for another paper I was forced to make some rather general statements on this subject and decided to find out just what actually happens when films are processed by both the rewind-spool method and the modern continuous processor. This project was given higher priority when we found ourselves faced with a relatively large programme involving the processing of 9½'' rolls of colour film which were to be processed to negative by the rewind method.

2. Method

The test for black and white films was designed to illustrate the variation in the degree of development across the width of the film as well as throughout the length of the roll. Two films were selected, Kodak Plus-X Aerographic type 2401 and Kodak Double-X Aerographic type 2405. The Plus-X was selected because of its inherently high contrast so that the results would be exaggerated and make it easier to detect agitation patterns. The Double-X was selected because it represents the film most used for general purpose photography in Canada at this point in time.

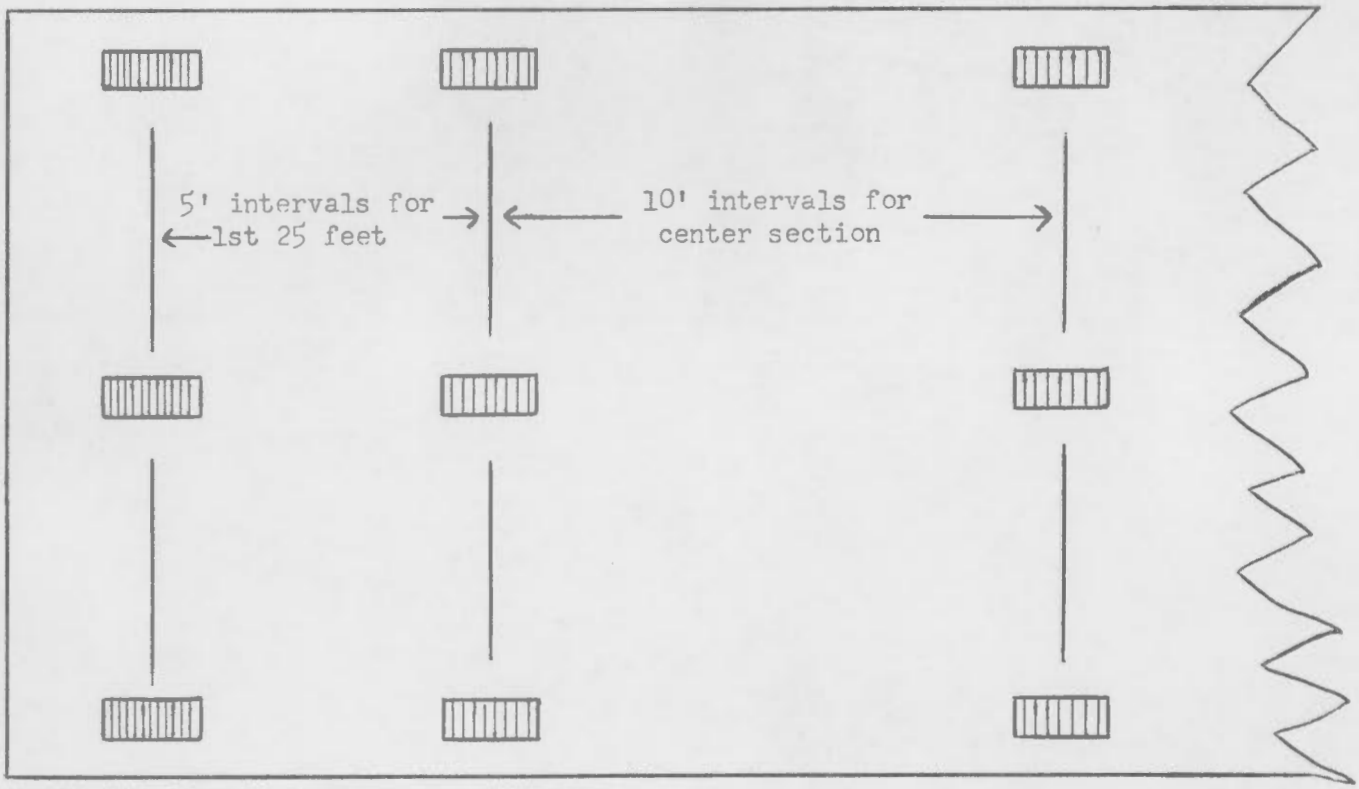
Due to the lack of a continuous processor capable of processing 9½'' colour film, it was only possible to process the colour film in the rewind method. A roll of Kodak Ektachrome Aero, type 8442 was processed in the rewind unit and the results are included as it was thought that the information was pertinent, even though a comparison of the two methods was not possible.

All films were processed in a Zeiss rewind unit model FE-120 and the two black and white films were also processed in a Versamat, model 11c, continuous processor. One further test was done on a Morse B5 rewind unit to eliminate the possibility that the patterns were a peculiarity of the Zeiss unit alone and not common to other rewind units. The black and white rolls did not have any images printed on them except the step tablets, while the colour film had the same image printed on its full length between the step tablets, to determine whether there was any evidence of chemical exhaustion. This resulted in the loss of some tablets due to double exposure. However enough good readings were available to establish the pattern.

3. Black and White Films

Two 125 foot rolls of Plus-X and the same lengths of Double-X were printed with step tablets on our NRC sensitometer in the manner shown in Figure 1. This was briefly, rows of three tablets printed across the width of the film at five foot intervals for the first 25' of each end and then at 10' intervals throughout the rest of the rolls.

The position of the film during processing is indicated by top, center and bottom for the rolls in the rewind unit and left, center and right for the continuous processor. This is the position of the film when you are facing the feed end of the processor with the emulsion up.



POSITIONING OF WEDGES

Figure 1

The step tablets were read on a MacBeth Densitometer model TD 102, the contrast index (1) determined for each step tablet, and the results plotted to show the degree of development received at each position throughout the rolls.

The Plus-X rolls were processed in D 19 developer, diluted 3 to 1 in the Zeiss rewind unit and in Versamat "A" chemistry in the continuous processor.

Note (1): The method employed for determining the contrast index for the black and white films was that recommended by the Canadian Standards Association. A line is drawn between two points on the characteristic curve and the contrast index determined in the same manner as in determining gamma. The position of the points being determined as follows:

"Point A - Represents that point on the curve where density is 0.3 above base and fog.

"Point B - With point A as center, an arc is drawn with its radius equal to 2.0 on the Log E or density scales". The point where this arc cuts the characteristic curve is point B.

The two 125 foot lengths of Double-X film (a 250 foot roll cut in half) were treated in the same manner except that the Double-X was processed in DK 50 in the rewind unit and the tablets were printed 1/2" further in from the edges in an effort to improve contact. The roll of colour film, a 75 foot roll of Ektachrome Aero type 8442, was pre-wet and processed in C22 chemistry at 75° F. It was given 12 minutes in the developer and had exposures printed on it between the rows of step tablets.

All films processed by the rewind method had a leader attached to one end only to illustrate the improvement produced by the use of a leader and trailer during the rewind method of processing.

It was thought advisable to alter the method of determining the contrast index for the colour roll due to the densities obtained on our sensitometer, and the two points selected were:

> Point A - .1 above base and fog, Point B - using Point A as center, describe an arc with a radius of 1.5 on density scale, Point B is where this arc cuts the characteristic curve. While this method established a contrast index having values different to those obtained by the method used for the black and white films, it is valid for comparison of the relative degrees of development received by the test areas for this film.

4. Results

In making any comparison of these two methods of processing it is necessary to comment briefly on what has always been considered to be the main fault inherent in the rewind method. This is the formation of bars of increased density, approximately one inch in width, across the width of the film. They start at the ends of the film and occur in decreasing density for distances of from several feet to, on rare occasions, the whole roll of film. They are caused by pressure on the emulsion at the point where the film enters the clamping device on the spool, and by splices in the film which also cause increased pressure at this point. The use of the very thin mylar tapes for splicing result in a reduction of the number of bars produced from the splice. These bars have always been present to some degree and nobody has come up with a method of eliminating them completely. No such bars are formed in the continuous processors now in use. The presence of these bars often result in the step tablets being useless for gamma determination and are the reason our graphs do not show contrast index values for the first five feet from each end of the film.

Plus-X - As expected the Plus-X produced a rather exaggerated result even though the dilution of the developer resulted in a reasonable degree of development in the rewind unit. Figures 2 and 3 compares the results obtained by both methods of processing and gives the details of the conditions under which the processing was carried out.

Double-X - The results from the Double-X comparison were as expected in that the lower contrast index resulted in smaller variations with the same basic patterns being produced. Figures 4 and 5 illustrates the difference between the two methods of processing for this

film. It is to be noted that the time in the developer was 17 minutes for a 125 foot roll in the rewind unit and no correction is evident with respect to the degree of development received in the center of the film as compared to the edges. It is therefore concluded that this difference is not a product of the shorter developing time given the Plus-X film.

NRC SENSITOMETER
DATE OF TEST 21 JUNE 67
FILM KODAK PLUS X TYPE 2401
DEV. D19 3 to 1 68°F 5 MIN. 20 SEC. 5 PASSES
ZEISS REWIND UNIT
NO LEADER
NO TRAILER
———TOP EDGE OF FILM IN TANK
·····CENTER OF FILM IN TANK
------BOTTOM EDGE OF FILM IN TANK

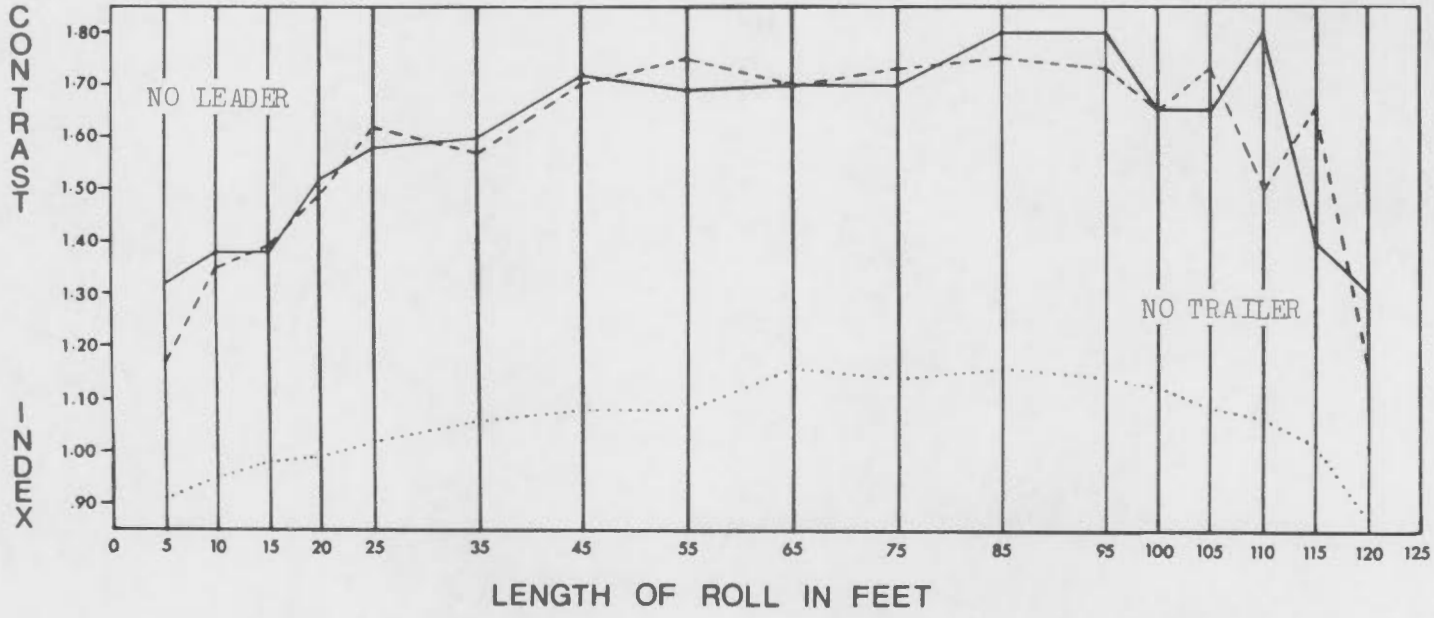


Figure 2

Plus-X, rewind method of Processing in Zeiss model FE 120 unit, D 19 developer diluted 3 to 1, 68°F for 5½ minutes.

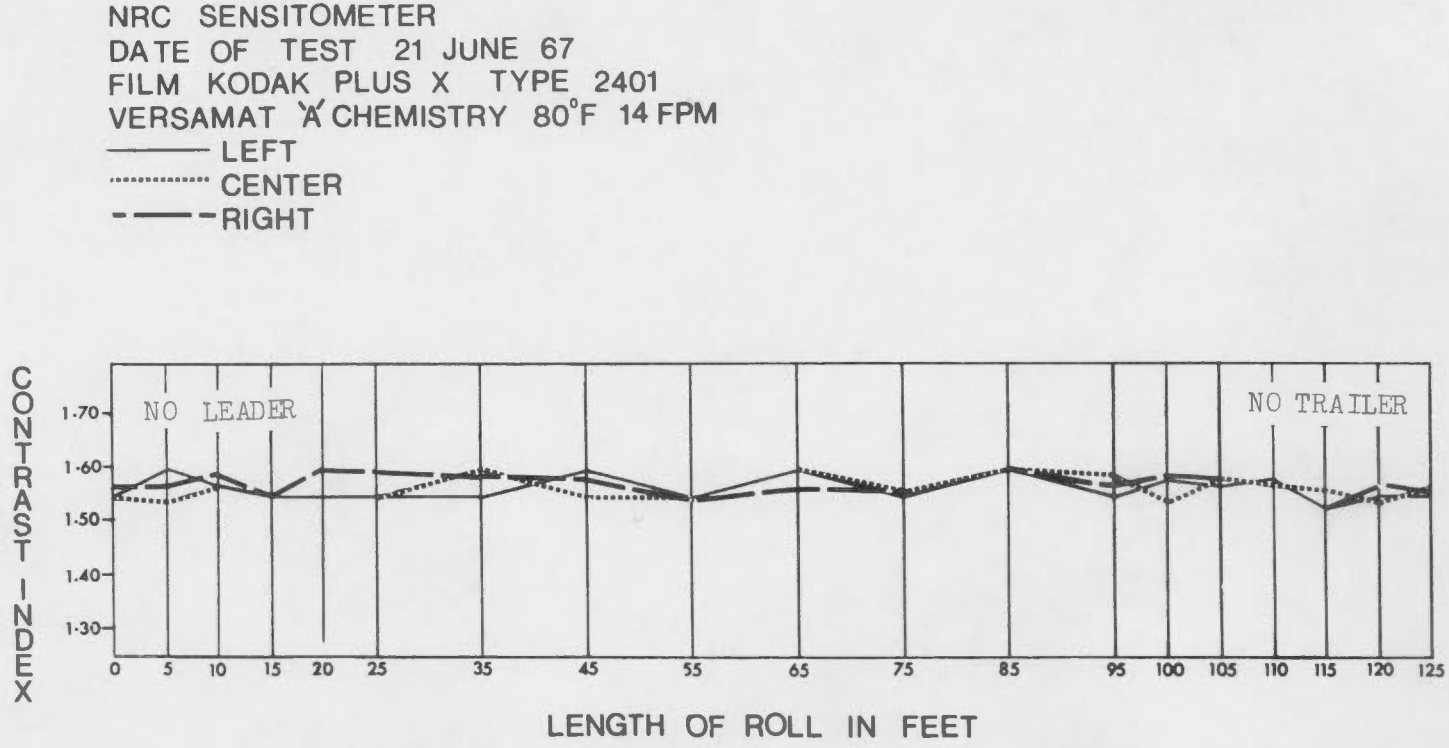


Figure 3

Plus-X - continuous Processor (Versamat Model 11c) Versamat "A" Chemistry 80°F at 14 feet per minute.

NRC SENSITOMETER
DATE OF TEST 5 JULY 67
FILM KODAK DOUBLE X
DEV. DK50 68°F 17 MIN 15 PASSES
ZEISS REWIND UNIT
15 FOOT LEADER
NO TRAILER
——— TOP EDGE OF FILM IN TANK
····· CENTER OF FILM IN TANK
- - - - - BOTTOM EDGE OF FILM IN TANK

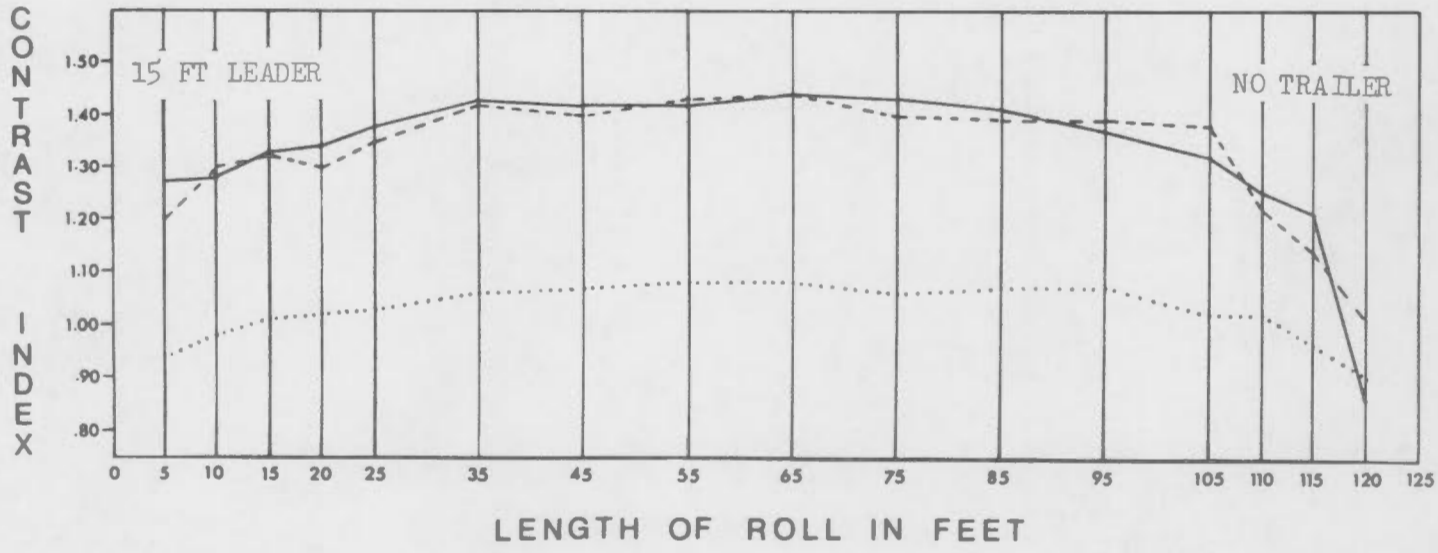


Figure 4

Kodak Double-X Aerographic, DK 50, 68°F for 17 minutes or 15 passes in Zeiss FE 120 rewind unit.

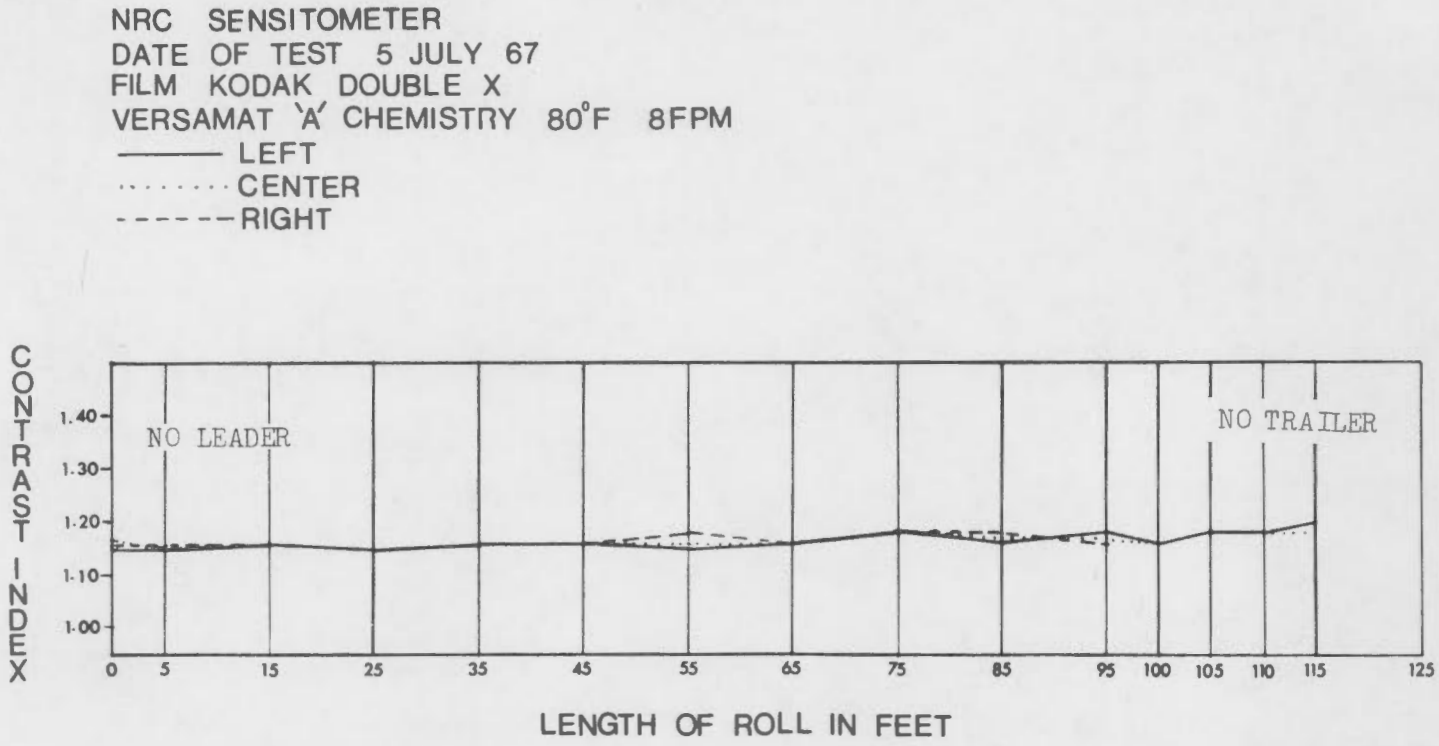


Figure 5

Kodak Double-X Aerographic -Versamat processor in Versamat "A" chemistry, 80°F at 8 feet per minute.

5. Negative Colour Film

The results obtained from the negative colour processing parallels the patterns produced on the black and white films.

Figure 6 represents the results obtained by averaging the densities of the red, green and blue filter readings for each step on the step tablet so that the three lines representing the top, center and bottom are an average contrast index of the three color densities. It is also to be noted that the method of determining the contrast index was altered for this film as described previously under "Methods" Figure 6 illustrates the results obtained with this film by the application of this method of measuring the degree of development.

Figure 7 represents the contrast index values for the red, green and blue filter readings of the step tablets along the top edge of the film. It is included, largely because it is a clear illustration of the value of splicing leaders and trailers to the film before processing in the rewind equipment. It is noted that most manufacturers do not attach leader and trailer to the rolls of colour film. The low red filter readings do not result from processing but is inherent in the colour balance of this particular emulsion as demonstrated by the manufacter's recommendation of a 20 cyan filter when exposing the film in the camera and processing to a positive.

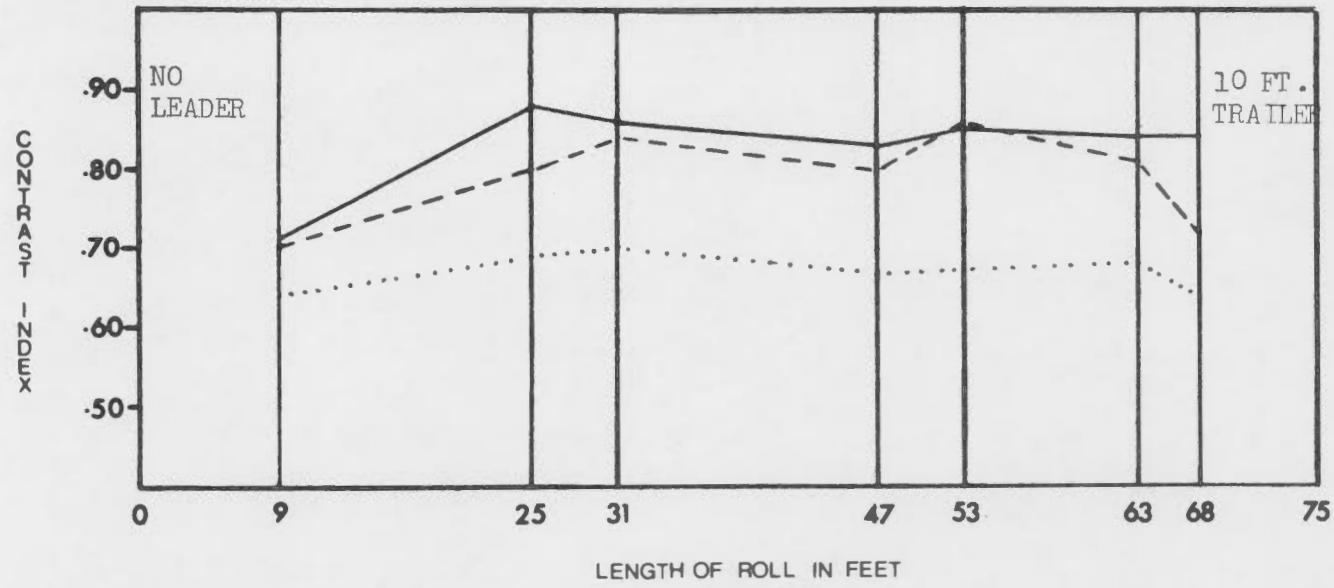


Figure 6

Kodak Ektachrome Aero, type 8442, processed to a negative in C22 chemistry, 75°F for 12 minutes in Zeiss FE 120 rewind unit.

NRC SENSITOMETER - NO FILTER
FILM - AERO EKTACHROME TYPE 8442
C22 PROCESS - NEGATIVE
TEMP. 75 F
DEV. - PASSES - 12, MIN.-12
ZEISS REWIND UNIT
POSITION OF WEDGESS - TOP IN TANK
"A" POSITION WEDGES
10 FOOT TRAILER NO LEADER

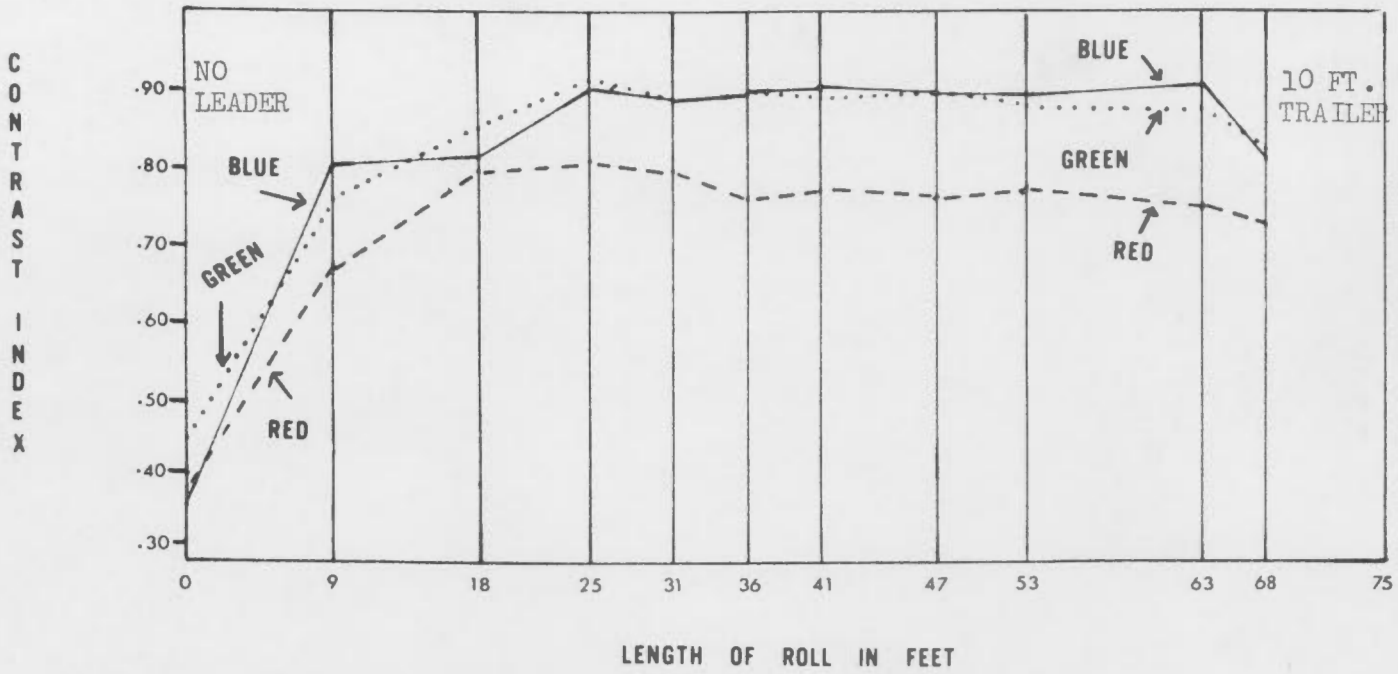


Figure 7

Contrast index of red, green and blue filter readings for step tablets along top edge of film.

B5 -Rewind Processor

Before arriving at conclusions with respect to the rewind method of processing, it was necessary to eliminate the possibility that the results obtained were peculiar to the Zeiss equipment only. To this end, a 125 length of Kodak Double-X film was processed in a Morse, B5 rewind unit and the results obtained are shown in Figure 8. It was not considered necessary to make further tests in the Versamat for comparison purposes.

NRC SENSITOMETER
DATE OF TEST 20 JULY 67
FILM KODAK DOUBLE X
DEV. DK50 68°F 15 MIN. 16 PASSES
MORSE B5 REWIND UNIT
15 FOOT LEADER
NO TRAILER
——— TOP EDGE OF FILM IN TANK
..... CENTER OF FILM IN TANK
------- BOTTOM EDGE OF FILM IN TANK

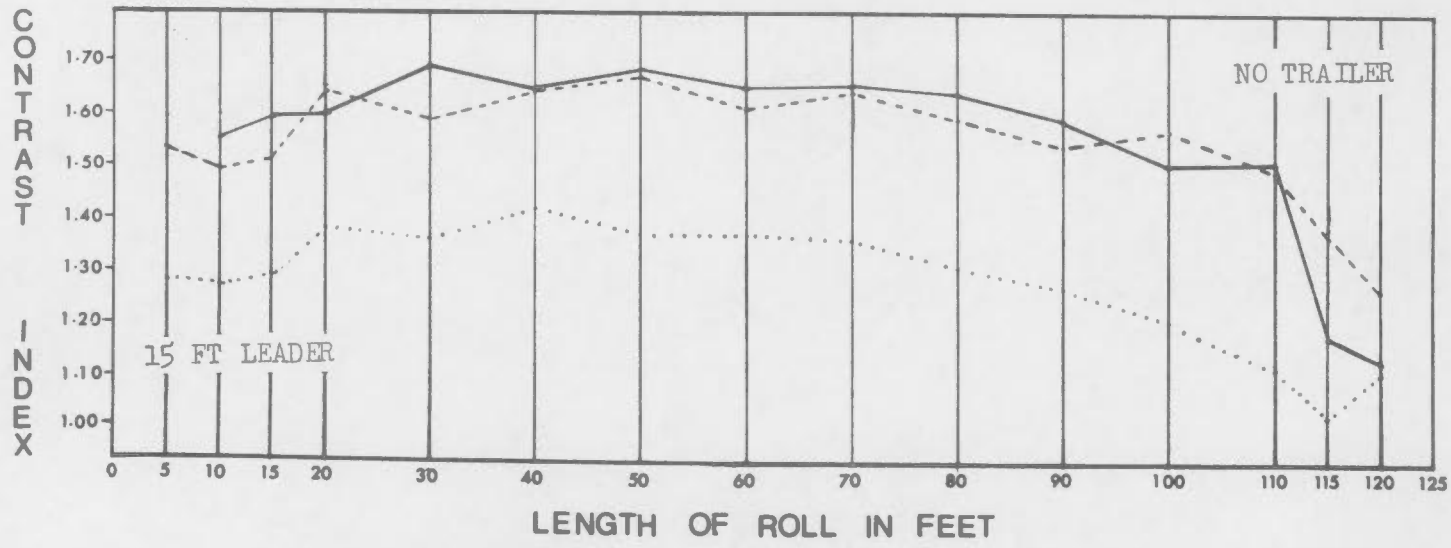


Figure 8

Kodak Double-X Aerographic in DK 50 developer at 68°F for 15 minutes or 16 passes in Morse B5 rewind unit.

The following table presents a condensed review of the information contained by the graphs as a quick reference to the results obtained. It represents the average contrast index for all the step tablets printed in each row along the length of the film, top, center and bottom for the rewind method and left, center, and right for continuous processing method. It only illustrates the average differences in development received across the width of the film and not the variations along the length.

TYPE OF FILM	TYPE OF PROCESSING	STEP TABLETS POSITION	AVERAGE CONTRAST INDEX	MAX. DIFF. EDGE TO CENTER.
Plus-X Aerographic		Top	1.58	
Type 2401	Rewind	Center	1.03	.55
		Bottom	1.57	
		Left	1.570	
	Continuous	Center	1.565	.005
		Right	1.570	
Double-X		Top	1.33	
	Rewind	Center	1.02	.31
		Bottom	1.32	
		Left	1.165	
	Continuous	Center	1.166	.002
		Right	1.167	
Kodak Aerial		Top	.82	
Ektachrome type 8442	Rewind	Center	.67	.15
(processed as negative)		Bottom	.79	
Double-X		Top	1.55	
	Morse B5	Center	1.28	.27
	Rewind	Bottom	1.55	

TABLE 1

6. Conclusions

While the rewind method of processing had always been known to result in less development at each end of the roll, as compared to the center, we had never known that such a large variation took place across the width of the film.

The results of these tests were rather startling and unexpected due to the extremely large variations encountered across the width of the film, combined with the consistency with which this pattern was repeated with different materials equipment, chemicals and duration of development. It apparently is a very real and inherent characteristic of the rewind method of development for 9½ inch rolls of film and in my opinion will prevail over an extremely wide range of processing times. It was also not considered practical, for the purposes of this paper, to pursue the hunt for the causes and remedies, as it would probably result in designing a whole new unit which is not considered practical when the performance of available continuous processors has reached the present degree of excellence.

It is now obvious that almost any contrast index may be obtained with a given development depending upon where the step tablets are printed on the roll. For example, in the case of the Double-X film processed in the Zeiss rewind unit, the contrast index varies from a low of .94 to a high of 1.45, or a contrast index difference of .51. The Plus-X, having a higher inherent contrast, covers a range from .87 to 1.80 for a difference of .93.

The Morse B5 test confirmed that the lack of development in the center of the film

was not due to any mechanical peculiarity inherent in the Zeiss unit.

The B5 unit produced a variation in contrast index, on a comparable test with the Zeiss unit, ranging from 1.04 to 1.70 for a difference of .66 as compared to .51 for the Zeiss. The pattern is remarkably similar even though the Morse B5 rewind motor runs at a higher speed than the Zeiss.

When it is considered that normal practice has been to print the step tablets in the center of the film, a few feet in from either end, it is obvious that the gamma, or contrast index, obtained is generally much lower than that obtained nearer the edges and center of the roll.

It is also obvious that any print production system is going to suffer greatly from such a wide variation in contrast throughout each negative, and roll of film, processed by the rewind method. This is particularly true in colour photography where it is economically essential to automate the printing process and maintain an acceptable degree of accuracy in both density and colour balance, as well as contrast.

On the other hand the results obtained from the continuous process method were better than expected and the average of the contrast index values obtained across the width of the film, as well as along the length, were so close that it is impossible to separate them for graphic illustration.

Even the high contrast Plus-X film showed no pattern as such, and a maximum variation of contrast index of .07.

It is therefore concluded that processing by the rewind method produces development variations which are not compatible with the negative quality demanded by to-days users of aerial photography, particularly where any degree of automation has been built into the reproduction facilities. It also points up a very definite requirement for a continuous roll film processor for aerial colour processes, a piece of equipment which the manufacturers have been very slow in developing and marketing.

The results obtained by this test throws grave doubts on the value of specifications which require the film to be processed to a specific gamma, or contrast index, within narrow tolerances, when the film is to be processed by the rewind method. The reverse is true when the film is to be processed by a modern continuous processor as it is obvious that the specifications could be met within very narrow tolerances and be constant throughout the whole roll.

7. Summary

It may be stated, from the evidence presented above, that the rewind method of processing 9½ inch rolls of aerial film, both black and white and colour, is not satisfactory for modern automated reproduction techniques or for obtaining an acceptable quality of photography for the more discerning and demanding users of aerial photography to-day.

These tests dramatically illustrate the uneven development obtained from rewind processing, even when the same equipment is operated by the same personnel with

all other variables kept within narrow tolerances. The error is greatly expanded when you consider that the film received by the Federal Government is processed by a large number of contractors, using different rewind equipment, different developers, and different technicians controlling the many variables inherent in roll film processing.

The advantages of using at least a 15 foot leader and trailer for the rewind method are clearly indicated by the higher contrast index at the end having a leader attached as compared to the end without leader (or trailer). The reduction in the amount of film spoilt due to processing bars is also appreciable, particularly when the newer ultra-thin mylar tapes are used to splice on the leaders and trailers.

It is also apparent that a modern continuous film processor is very well designed as to method of agitation, control of transport speed, and effectiveness of the replenishment system. It enables the operator to predict the degree of development within extremely fine tolerances, and to process all sizes of aerial film without processing bars or other physical defects.

It is obvious that where quality is a major factor the rewind method has outlived its usefulness and should only be used where it is impossible to get the film to a continuous processor.

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