NASA CR-
141553

INTERIM

TECHNICAL NOTE

Separation Negatives from Kodak Film Types SO-368 and SO-242

Prepared Under
Task Order HT-51
Contract NAS 9-11500

Written by

Mark S. Weinstein
Photoscientist

17 May 1972

Photographic Technology Division
National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

Technicolor Graphic Services, Inc.

Separation Negatives from Kodak Film Types SO-368 and SO-242

This Report has been reviewed

and is approved.

Noel T. Lamar
Technical Monitor

Gerard E. Sauer
Technicolor Graphic Services, Inc.

SUMMARY

Two master resolution friskets were produced on Kodak Film Types SO-368 and SO-242. These target masters consisted of 21 density steps with three-bar resolution targets at five modulation levels within each step.

The target masters were contact printed onto Kodak Separation Negative film, type 4131, using both a contact printing frame and enlarger as one method of exposure, and a Miller-Holzwarth Contact Printer as the other exposing device. Red, green, and blue Wratten filters were used to filter the exposing source. Tray processing was done with DK-50 developer diluted 1:2 at a temperature of 70°F.

The resolution values were read for the SO-368 and SO-242 target masters, and the red, green, and blue separation negatives.

An analysis of the resolution values obtained showed more loss in resolution between the SO-242 target master and its separation negatives than between the SO-368 target master and its separation negatives. The blue record from the SO-368 target master and the green record from the SO-242 target master showed better resolution than the other two records for each type film. There is no significant difference in resolution when comparing the two techniques used to make the separation negatives.

PROCEDURES

A. Production of Master Resolution Frisket

A modulation/resolution target master consisting of 21 rows of 256 line-per-millimeter resolution targets with 5 modulation levels in each row, was placed over the 21-step tablet in the Photographic Technology Division (PTD) Type I-B Precision Sensitometer. The 21 rows of the target master corresponded to the 21 steps of the step tablet. The sensitometer was used to expose the step tablet and target master onto Kodak Color Reversal Film, types SO-368 and SO-242. The sensitometer lamp was set at a color temperature of 2850°K and filtration was used to simulate 5500°K daylight. An exposure time of 1/50 second was used for type SO-368 film, and an exposure time of 1/25 second was used for type SO-242 film.

The type SO-368 film was processed in the Hi-Speed Processor with ME-2A chemistry, and the type SO-242 film was processed in the Kodak Model 1811 Versamat with EA-5 chemistry.

The densities were read for both the SO-368 and SO-242 target masters on a MacBeth TD217DR densitometer with a 2mm aperture using Status A filters. Figures 1 through 4 are the resultant D-Log E curves.

The resolution targets were read at 100x magnification with an American Optical Company microscope using a 10x objective and a 10x eyepiece. The resolution readings at various density levels and all 5 modulations are presented in Table I for the SO-368 film and in Table II for the SO-242 film.

B. Production of Separation Negatives (Method I)

This section describes the first of two techniques used to produce separation negatives.

The SO-368 target master was contact printed onto Kodak Separation Negative film, type 4131, using a contact printing frame to hold the two films together and a Leitz Focomat IIC enlarger with a 60mm lens set at an aperture of f4.5 as the exposing source. The distance from film to enlarger lens was 12 inches.

Red, green, and blue separations were made by exposing the separation negative film through the target master using Wratten #25, #58, and #47B filters, respectively, to filter the light coming from the enlarger. The red separation was exposed for 3 seconds; the green

DATE 5-11-12 CONTROL # _____ TASK H1 - 51 PREPARED BY GM

FILM SO 368 EMULSION # 18-32 MFG EK EXPIRATION DATE _____

EXPOSURE DATA		PROCESSING DATA		DENSITOMETRY			
SENSITOMETER	1B	PROCESSOR	Hi-Speed	INSTRUMENT	MacB.	SPEED ( )	
ILLUMINANT	2850 °K	CHEMISTRY	MF2A	TYPE	TD 211 DR	D-MAX	
TIME	1/50" SEC.	SPEED	TANKS FPM	APERTURE SIZE	2 MM	GAMMA	
FILTER	5500°K	TEMP °F	TIME	FILTER	STATE A	BASE + FOG	

CHEMICAL ANALYSIS

SP GR

pH

TA

TFP

KB_r

21	
20	
19	
18	
17	
16	
15	
14	
13	
12	
11	
10	
9	
8	
7	
6	
5	
4	
3	
2	
1	

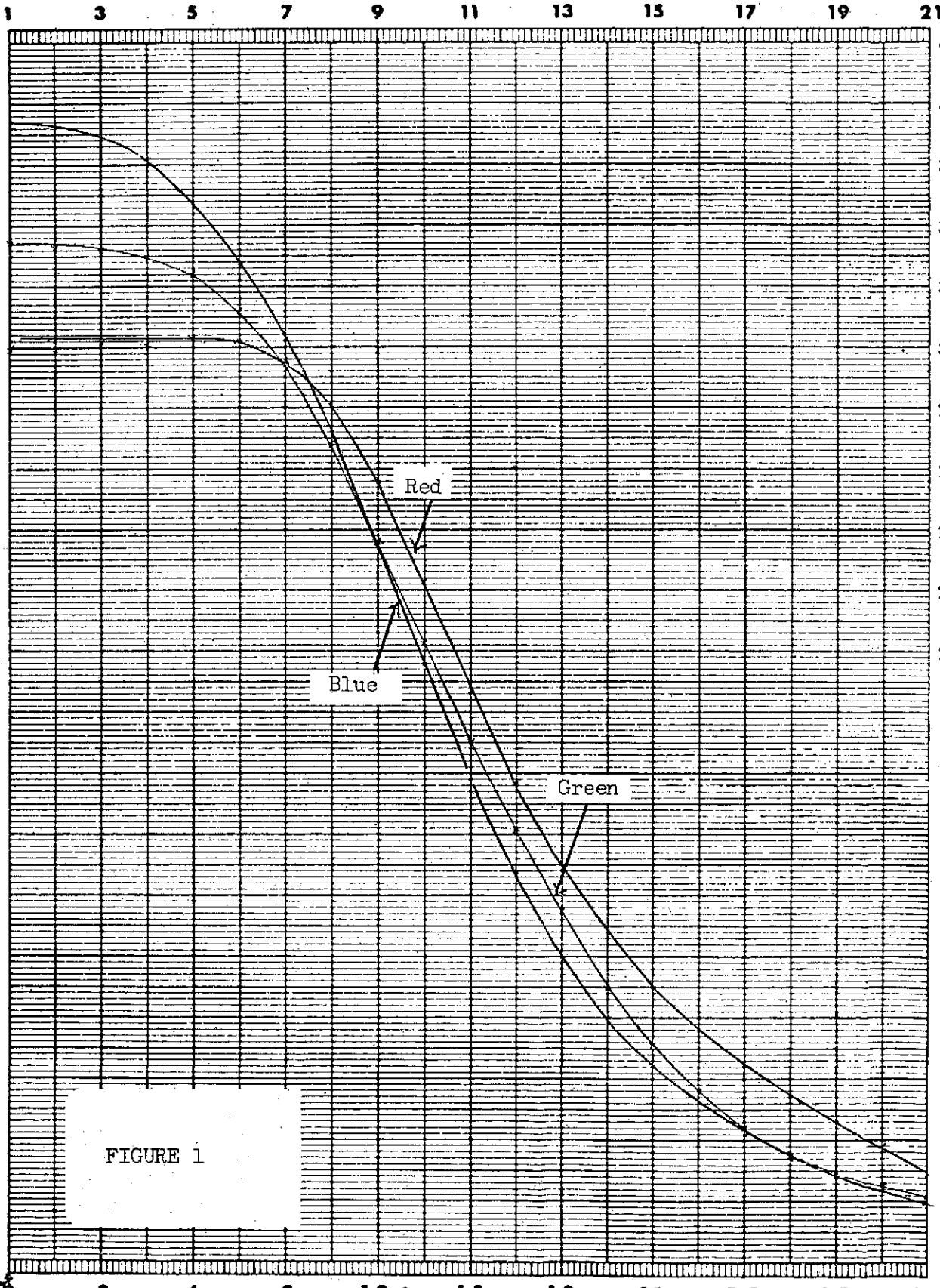


FIGURE 1

Technicolor

ABSOLUTE LOG E AT R.L.E. = 0

-10

T71-21

☆ U.S. GOVERNMENT PRINTING OFFICE: 1972—779-257/77

DATE 5-11-72 CONTROL # _____ TASK HT-31 PREPARED BY GM

FILM 50-368 EMULSION # 1832 MFG EK EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER IB	PROCESSOR Hi-Speed	INSTRUMENT MacB-
ILLUMINANT 2850 °K	CHEMISTRY ME2A	TYPE TD 2170R
TIME 1/50" SEC.	SPEED ____ TANKS ____ FPM	APERTURE SIZE 2 MM
FILTER 5500°K	TEMP °F ____ TIME ____	FILTER Visual

SPEED ( ) ____
D-MAX ____
GAMMA ____
BASE + FOG ____

CHEMICAL ANALYSIS

SP GR

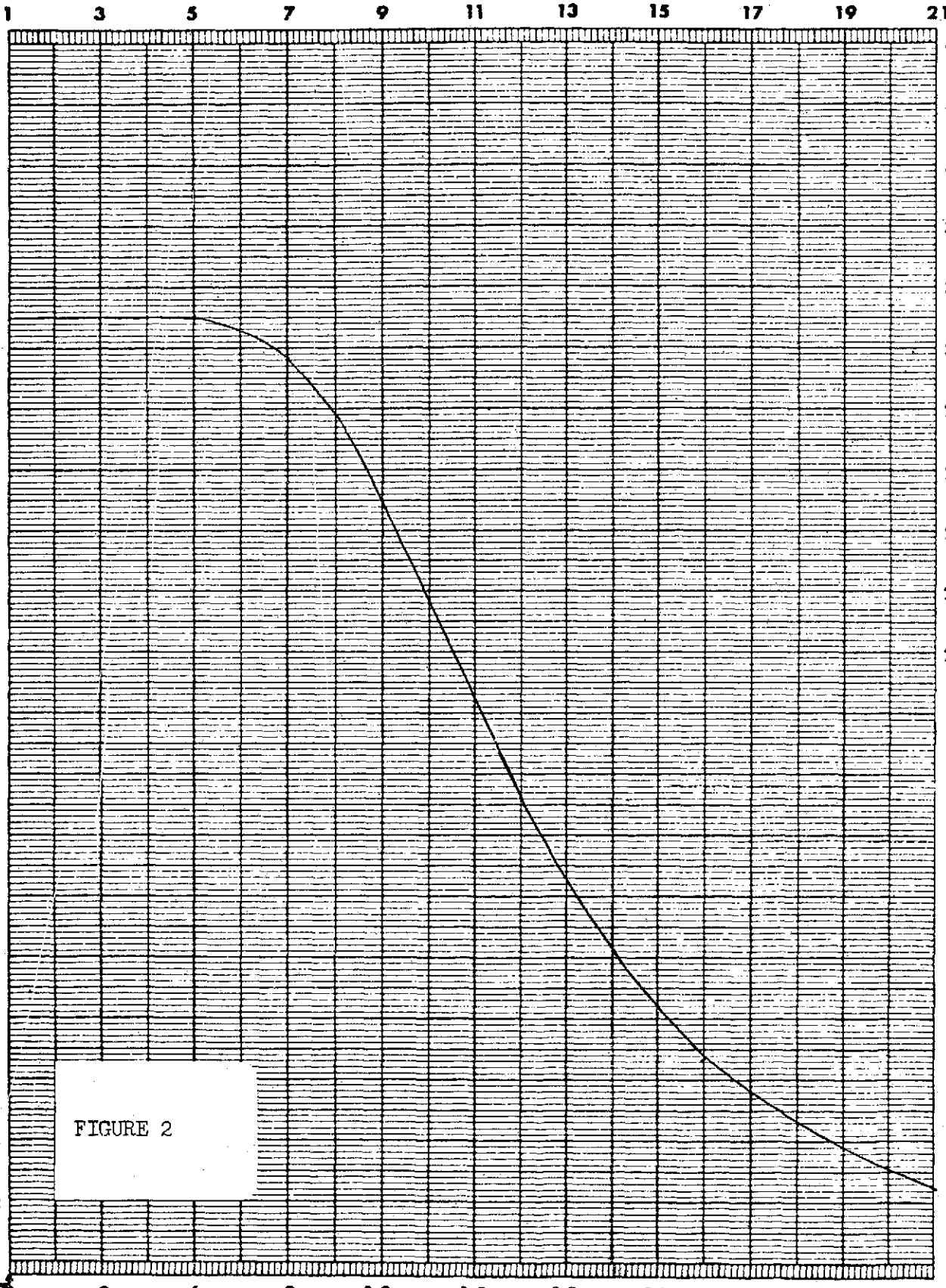
pH

TA

TFP

KB_r

21	
20	
19	
18	
17	
16	
15	
14	
13	
12	
11	
10	
9	
8	
7	
6	
5	
4	
3	
2	
1	



Technicolor

FIGURE 2

ABSOLUTE LOG E AT R.L.E. = 0 −10

T71-21

☆ U.S. GOVERNMENT PRINTING OFFICE: 1972—779-257/77

DATE 5-11-72 CONTROL # _____ TASK H1-50 PREPARED BY GM

FILM 50242 EMULSION # 17-2 MFG EK. EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER 1B	PROCESSOR Vmat 181	INSTRUMENT MacB.
ILLUMINANT 2850 K	CHEMISTRY EA-5	TYPE TD2 17 DR
TIME 1/25" SEC.	SPEED ____ TANKS ____ FPM	APERTURE SIZE 2 MM
FILTER 5500°K	TEMP °F ____ TIME ____	FILTER STAT A
		SPEED ( ) ____
		D-MAX ____
		GAMMA ____
		BASE + FOG ____

CHEMICAL ANALYSIS

SP GR

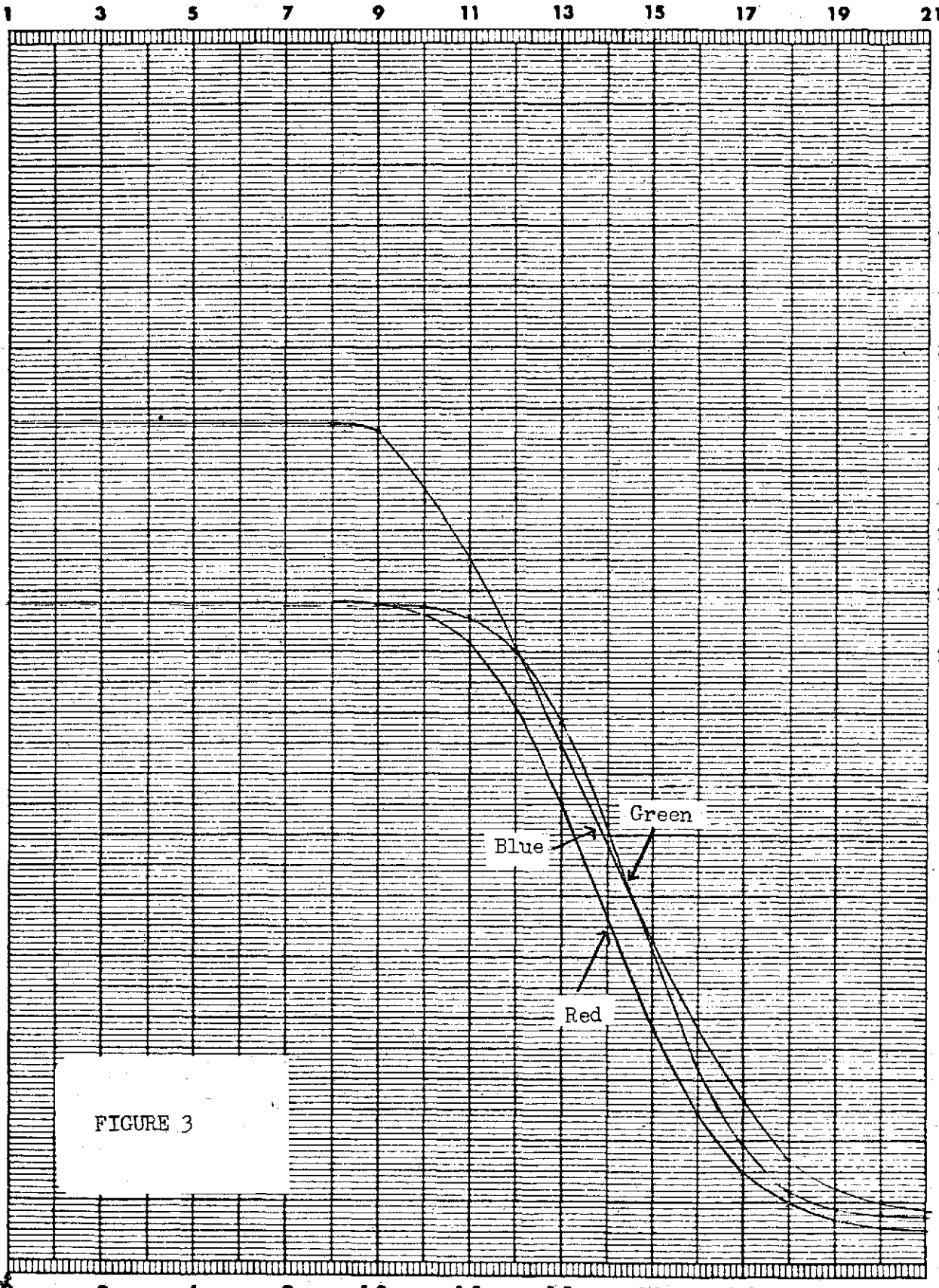
pH

TA

TFP

KB_r

21	
20	
19	
18	
17	
16	
15	
14	
13	
12	
11	
10	
9	
8	
7	
6	
5	
4	
3	
2	
1	



Technicolor

FIGURE 3

ABSOLUTE LOG E AT R.L.E. = 0

-10

T71-21

☆ U.S. GOVERNMENT PRINTING OFFICE: 1972—779-257/77

DATE 5-11-72 CONTROL # _____ TASK 41-51 PREPARED BY GM

FILM 5024 EMULSION # 17-2 MFG EK EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER 1B	PROCESSOR Mat 1811	INSTRUMENT MacB
ILLUMINANT 2850 °K	CHEMISTRY EA-5	TYPE TD 211 DR
TIME 1/25" SEC.	SPEED _____ TANKS _____ FPM	APERTURE SIZE 2 MM
FILTER 5500°K	TEMP °F _____ TIME _____	FILTER Visual
		SPEED ( ) _____
		D-MAX _____
		GAMMA _____
		BASE + FOG _____

CHEMICAL ANALYSIS

SP GR _____

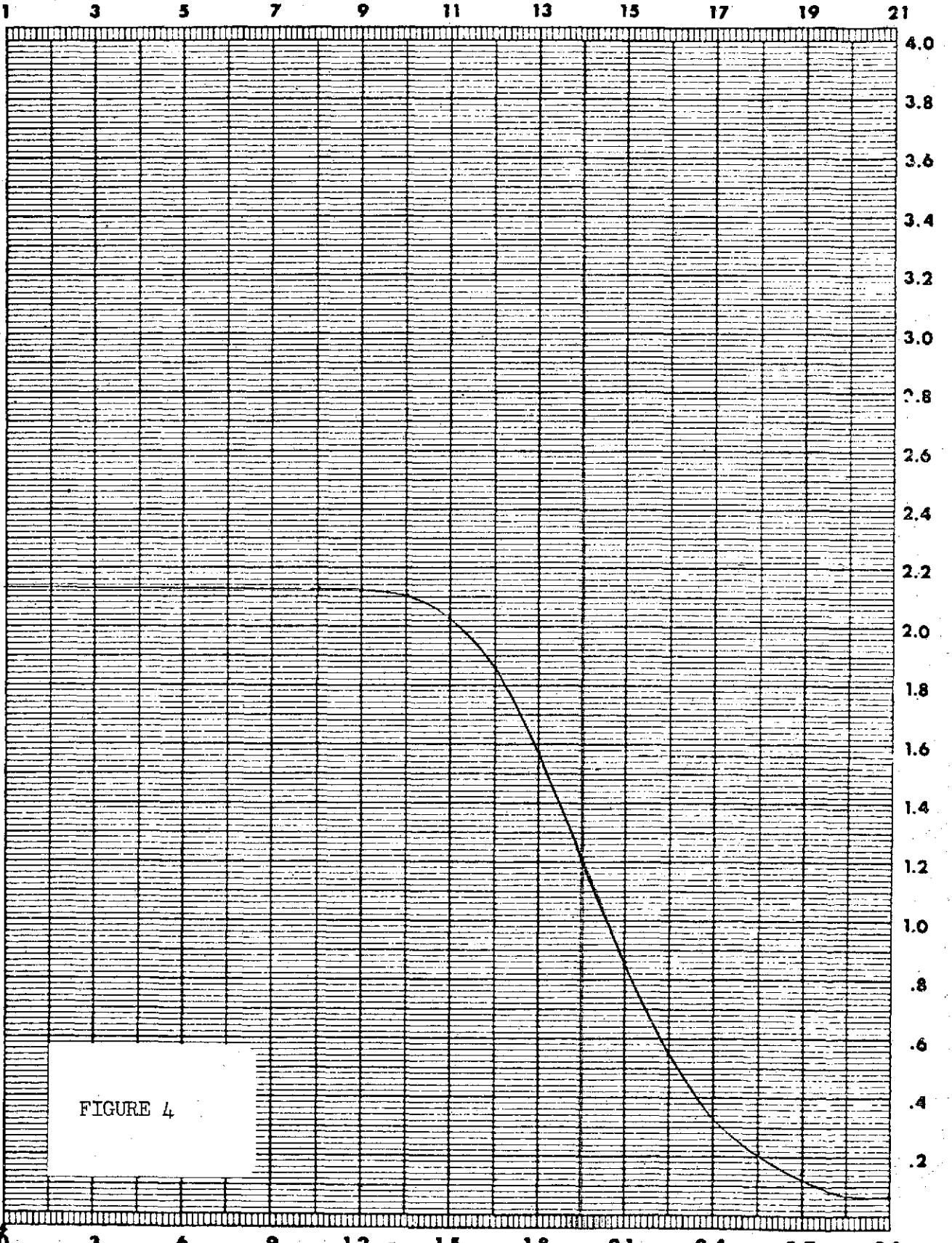
pH _____

TA* _____

TFP _____

KB_r _____

21	
20	
19	
18	
17	
16	
15	
14	
13	
12	
11	
10	
9	
8	
7	
6	
5	
4	
3	
2	
1	



Technicolor

FIGURE 4

T71-21

☆ U.S. GOVERNMENT PRINTING OFFICE: 1972—779-257/77

TABLE I

SO-368 Target Master Resolution Values

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm	LOW CONTRAST TARGET l/mm
1	40	32	32	25	--
2	36	36	32	28	16
3	40	40	36	32	18
4	40	40	36	32	18
5	40	36	32	32	20
6	36	36	32	32	23
7	36	40	32	25	20
8	32	32	28	23	18
9	28	32	32	28	18
10	32	28	23	18	16
11	25	28	23	18	--
12	23	20	16	20	20
13	18	18	16	--	--

TABLE II

SO-242 Target Master Resolution Values

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm	LOW CONTRAST. TARGET l/mm
1	102	72	64	36	0
2	102	81	72	51	0
3	114	102	90	72	40
4	114	102	90	81	51
5	81	90	81	72	45
6	72	81	81	72	45
7	57	81	72	57	40
8	57	72	72	57	40
9	40	45	51	51	32
10	28	36	40	40	20
11	32	32	25	20	18

separation was exposed for 6 seconds; and the blue separation was exposed for 18 seconds.

Processing of the separation negative material was done in a tray with Kodak DK-50 developer diluted 1:2 at 70°F. The processing times used were 4 minutes for the red separation negative, 3.5 minutes for the green separation negative, and 4.5 minutes for the blue separation negative.

After processing, the resolution values for the three separations were read. All five modulation targets were read at six successive density steps corresponding to the six steps having the highest resolution on the original. The resultant resolution values can be found in Tables III, A through C.

The same procedures were followed for the SO-242 target master. The only change was in exposure time for the three separation negatives. The red record was exposed for 1 second; the green record was exposed for 2 seconds; and the blue record was exposed for 6 seconds. The resolution values were determined in the same manner as for the SO-368 target master and are tabulated in Tables IV, A through C.

C. Production of Separation Negatives (Method II)

This section describes the second of two techniques used to produce separation negatives. This approach was intended to improve the resolution capability over that obtained in Method I.

The Miller-Holzwarth Contact Printer was used to expose the separation negative film. This contact printer was designed to produce contact prints from high resolution original imagery with a minimum loss in information content.

The SO-242 target master and the separation negative film were placed, emulsion to emulsion, on the platen of the printer. Red, green, and blue Wratten gelatin filters were taped to the printer filter wheel to produce the filtration required. The red separation negative was made using the Wratten #26 filter and an exposure time of 1 second; the green separation negative was made with the Wratten #58 filter and an exposure time of 2 seconds; and the blue separation negative was made with a Wratten #48 filter and an exposure time of 6 seconds. Processing was accomplished using the tray method and DK-50 developer diluted 1:2 at 70°F. Processing times were identical to those used in Method I.

The resolution targets were read in the same manner as in Method I. The resultant values are shown in Tables V, A through C.

TABLE III-A

Separation Negative Resolution Values
SO-368 Blue Separation (Wr 47B)

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm	LOW CONTRAST TARGET l/mm
1	--	--	--	--	--
2	36	32	32	25	--
3	36	32	32	28	18
4	36	32	28	25	18
5	36	32	32	25	23
6	36	32	32	23	18
7	28	28	25	23	18

TABLE III-B

Separation Negative Resolution Values
SO-368 Green Separation (Wr 58)

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm	LOW CONTRAST TARGET l/mm
1	--	--	--	--	--
2	23	20	16	--	--
3	23	23	20	16	--
4	25	23	23	18	--
5	25	23	20	18	--
6	23	23	20	18	--
7	23	23	20	18	--

TABLE III-C

Separation Negative Resolution Values
SO-368 Red Separation (Wr 25)

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm	LOW CONTRAST TARGET l/mm
1	--	--	--	--	--
2	23	20	18	16	--
3	23	20	18	16	--
4	23	23	20	18	--
5	23	20	20	16	--
6	23	20	20	16	--
7	20	20	18	16	--

TABLE IV-A

Separation Negative Resolution Values
SO-242 Blue Separation (Wr 47B)

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm	LOW CONTRAST TARGET l/mm
1	40	28	23	16	--
2	40	36	25	20	--
3	40	36	32	20	--
4	36	32	28	20	--
5	32	32	23	18	--
6	25	25	23	18	--

TABLE IV-B

Separation Negative Resolution Values
SO-242 Green Separation (Wr 58)

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm	LOW CONTRAST TARGET l/mm
1	57	45	28	18	--
2	51	51	36	20	--
3	64	51	40	28	--
4	51	51	45	36	20
5	51	51	40	36	23
6	40	45	40	32	20

TABLE IV-C

Separation Negative Resolution Values
SO-242 Red Separation (Wr 25)

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm	LOW CONTRAST TARGET l/mm
1	45	36	28	20	--
2	45	40	32	20	--
3	51	40	32	23	--
4	57	45	36	28	20
5	45	45	40	32	20
6	45	45	40	32	23

TABLE V-A

Separation Negative Resolution Values
(Miller Holzwarth Contact Printer)
SO-242 Blue Separation (Wr 48)

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm →	LOW CONTRAST TARGET l/mm
1	40	32	23	18	--
2	40	36	28	20	--
3	45	40	32	23	--
4	40	36	28	23	--
5	32	32	28	23	--
6	28	28	25	18	--

TABLE V-B

Separation Negative Resolution Values
(Miller Holzwarth Contact Printer)
SO-242 Green Separation (Wr 58)

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm	LOW CONTRAST TARGET l/mm
1	57	45	32	32	16
2	64	51	40	25	--
3	64	57	45	32	18
4	57	57	45	36	20
5	45	51	45	36	23
6	36	45	40	32	20

TABLE V-C

Separation Negative Resolution Values
(Miller Holzwarth Contact Printer)
SO-242 Red Separation (Wr 26)

STEP	HIGH CONTRAST TARGET l/mm	l/mm	l/mm	l/mm	LOW CONTRAST TARGET l/mm
1	45	36	25	18	--
2	45	36	32	23	--
3	51	45	36	25	--
4	51	45	36	28	18
5	45	45	40	32	20
6	40	45	40	36	20

D. Reconstruction of the Separation Negatives Utilizing the PTD International Imaging Systems (I^2S) Additive Viewer/Printer

The red, green, and blue separation negatives made from the SO-368 target master were cut to fit the I^2S film holder. The film size allowed by the holder encompassed the 6 density levels for which the resolution values had been previously determined. The separations were placed in the film holder which was then returned to the viewer. The images were projected and viewed on the ground glass screen. The viewed images were obviously out of focus. There is no simple means for focusing the viewer; the lens position and the viewing screen placement are essentially fixed. Any out-of-focus situation with the I^2S viewer would prevent obtaining meaningful resolution values both in the viewing and the printing modes. Due to this focus problem and the time frame allocated for the Task, it was decided not to continue with this phase of the project.

CONCLUSIONS

A. There is no significant difference in resolution obtained by either of the two techniques tested for producing separation negatives.

B. The resolution of the blue separation negative is greater than the green or the red separation negatives made from the SO-368 target master.

C. The resolution of the green separation negative is greater than the blue or the red separation negatives made from the SO-242 target master.

D. Since the top emulsion layer for film type SO-368 is the blue record, and the top emulsion layer for film type SO-242 is the green layer, and based on the data obtained leading to conclusions B and C above, it is further concluded that the order of the emulsion layers in a color film affects the resolution ability of the three separation negatives. The upper layer produces the highest separation negative resolution and the bottom layer produces the lowest separation negative resolution.

E. For the techniques tested, the loss in resolution when comparing the separation negatives to their respective target master is greater for the SO-242 target master than for the SO-368 target master. This is shown in terms of percent resolution loss in Table VI. In all cases, the highest recorded resolution values were used for the comparison.

F. Further testing should be performed using other film types and/or techniques for making separation negatives to try and improve resolution retention.

TABLE VI

Percent Resolution Loss
Between
Target Masters and the Separation Negatives

	SO-368 Target Master			SO-242 Target Master		
	Blue	Green	Red	Blue	Green	Red
High Contrast Target ↓ Low Contrast Target	10	37.5	42.5	60.5	43.8	55.3
	20	42.5	42.5	60.8	44.1	55.9
	11	36.1	44.4	64.4	50.0	55.6
	12.5	43.75	43.75	71.6	55.6	60.8
	0	--	--	--	55.0	61.0