TECHNICAL NOTE

Special Processing of Apollo 16 Pan Camera Film

Prepared Under

Task Order HT-28
(Contract NAS 9-11500)

Written by

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Manned Spacecraft Center
Houston, Texas

TR 72-3 56/73

Technicolor Graphic Services, Inc.

SPECIAL PROCESSING, APOLLO 16 PAN CAMERA FILM

This Report has been reviewed

and is approved.

John R. Brinkmann, Chief
Photographic Technology Division

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Technical Monitor

Gerard E. Sauer, Supervisor
Photo Science Office

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SUMMARY

Due to the exposure conditions of the Apollo 16 Pan Camera imagery, a series of tests were run to determine if it is possible to

1. maintain toe speed to preserve the normally exposed near-terminator imagery, and
2. retain an acceptable density range for the two stop overexposed portion of the imagery.

A set of processing conditions (80°F, 15 fpm) was found which provide a significant improvement over the Standard Apollo 16 Control for Film Type 3414 in meeting the above requirements.

PROCEDURES AND RECOMMENDATIONS

Improper operation of the Apollo 16 Panoramic Camera Automatic Exposure Control caused the majority of the imagery to be over-exposed by 1½ to 2 stops. As requested, the Photo Science Office has investigated the problem and arrived at a logical approach to its solution.

Eighteen frames of Apollo 15 Pan Camera imagery were chosen representing imagery taken at sun angles of 12° to 50° in both the fore and aft looking modes. The minimum and maximum densities of each frame were determined with a MacBeth densitometer utilizing a 2mm aperture. These readings are shown in Table 1, and the density ranges for eight representative frames are plotted in Figure 1. If these frames had been 2 stops over-exposed, what would have happened to the imagery?

The effect of a two-stop overexposure is shown graphically in Figure 1 and is tabulated in Table 1. The result is an increase in density due to overexposure and a decrease in density range due to placement of the imagery on the shoulder of the D-Log E curve, both of which are undesirable due to a loss of information content. The normal method to use in correcting this situation would be to maintain the same D-Log E curve shape, but to displace it 0.6 Log E units to the right, thereby restoring the exposures to their planned position on the curve. However, the Apollo 16 near-terminator photography was properly exposed near the toe of the D-Log E curve. This means that the toe cannot be moved without adversely affecting the near-terminator photography.

In order to maintain the toe speed while reducing the densities of the overexposed high sun angle imagery, the process gamma must be changed. Gamma must be reduced sufficiently to place the overexposed imagery on the straight line (or near-straight line) portion of the curve without affecting the toe speed.

To determine the optimum processing conditions for the Apollo 16 Pan Camera imagery, a time/temperature series was run in the Fultron Processor with Type 3414 flight film using MX-819 chemistry. A series of four temperatures and four machine speeds were used to give a good indication of the spectrum of D-Log E curves available. These curves are included in the Appendix. Two of the more promising curves, 80° F./15 fpm, and 85° F./25 fpm, were chosen for further analysis.

Table 2 shows the resultant density analysis, and Figure 2 is a plot of the D-Log E curves described, along with the present Apollo 16 control curve obtained by developing at 90° F. with a machine speed of 20 fpm. E_{min} and E_{max} columns in Table 2 are obtained from the two-stop overexposure condition shown in Figure 1. An examination of the ΔD column of Table 2 shows that the 80° F./15 fpm curve indicates an improvement in density range and a lowering of densities over the Standard Control curve, while the 85° F./25 fpm curve indicates a decrease in density range. The toe speed measured at 0.1 above base-plus-fog shows a .06 loss for the 80° F./15 fpm curve, and .13 loss for the 85° F./25 fpm curve as compared to the Standard Control curve.

This analysis indicates that for the exposure conditions of the Apollo 16 Pan Camera imagery (normally exposed terminator, two-stop overexposure remainder) the optimum processing conditions are approximately 80° F. and 15 fpm. This results in a minimum loss of toe speed for the near-terminator photography while increasing the density range of the overexposed high sun angle photography over the range obtainable with the Standard Apollo 16 Control for Type 3414 Film.

TABLE 1

FRAME	SOLAR ALTITUDE	FORE/AFT	D_{min}	D_{max}	ΔD	2-stop over Dmin	2-stop over Dmax	2-stop over ΔD
9370	14	FORE	0.80	1.92	1.12	1.84	2.46	0.62
9375	13	AFT	0.56	1.56	1.00			
9377	12	AFT	0.56	1.73	1.17	1.53	2.42	0.89
9427	23	FORE	0.75	1.89	1.14	1.78	2.44	0.66
9430	23	AFT	0.61	1.97	1.36	1.56	2.46	0.90
9793	34	FORE	0.81	1.89	1.08	1.82	2.49	0.67
9798	32	AFT	0.90	1.79	0.89	1.95	2.42	0.47
9800	32	AFT	0.78	1.78	1.00			
9809	43	FORE	1.31	1.81	0.50	2.19	2.42	0.23
9814	41	AFT	1.38	1.94	0.56	2.27	2.46	0.19
8872	15	FORE	0.57	1.82	1.25			
8877	15	AFT	0.54	1.66	1.12			
8922	30	FORE	0.66	1.62	0.96			
8927	30	AFT	0.75	1.65	0.90			
8983	40	FORE	0.92	1.86	0.94			
8988	40	AFT	0.94	1.72	0.78			
9017	50	FORE	1.13	1.76	0.63			
9022	50	AFT	1.13	1.66	0.53			

TABLE 2

FRAME	Emin	Emax	80° 15 fpm Dmin	80° 15 fmp Dmax	ΔD	85° 25 fpm Dmin	85° 25 fpm Dmax	ΔD
9370	2.24	2.88	1.47	2.17	0.70	1.18	1.75	0.57
9377	1.98	2.80	1.12	2.09	0.97	0.91	1.68	0.77
9427	2.20	2.90	1.43	2.18	0.75	1.12	1.76	0.64
9430	2.10	2.96	1.28	2.22	0.94	1.03	1.80	0.77
9793	1.63	2.88	0.62	2.17	1.55	0.53	1.67	1.14
9798	2.32	2.86	1.57	2.15	0.58	1.26	1.73	0.47
9809	2.54	2.84	1.84	2.12	0.28	1.47	1.72	0.25
9814	2.62	2.94	1.92	2.21	0.29	1.53	1.78	0.25

DATE _____ CONTROL # _____ TASK Apollo 15 PREPARED BY G.M.

FILM 3414 EMULSION # _____ MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER _____	PROCESSOR _____	INSTRUMENT _____	SPEED ( ) _____
ILLUMINANT _____ °K	CHEMISTRY _____	TYPE _____	D-MAX _____
TIME _____ SEC.	SPEED _____ TANKS _____ FPM	APERTURE SIZE _____ MM	GAMMA _____
FILTER 4750°K	TEMP °F _____ TIME _____	FILTER _____	BASE + FOG _____

CHEMICAL ANALYSIS

SP GR _____

pH _____

TA _____

TTP _____

KBr _____

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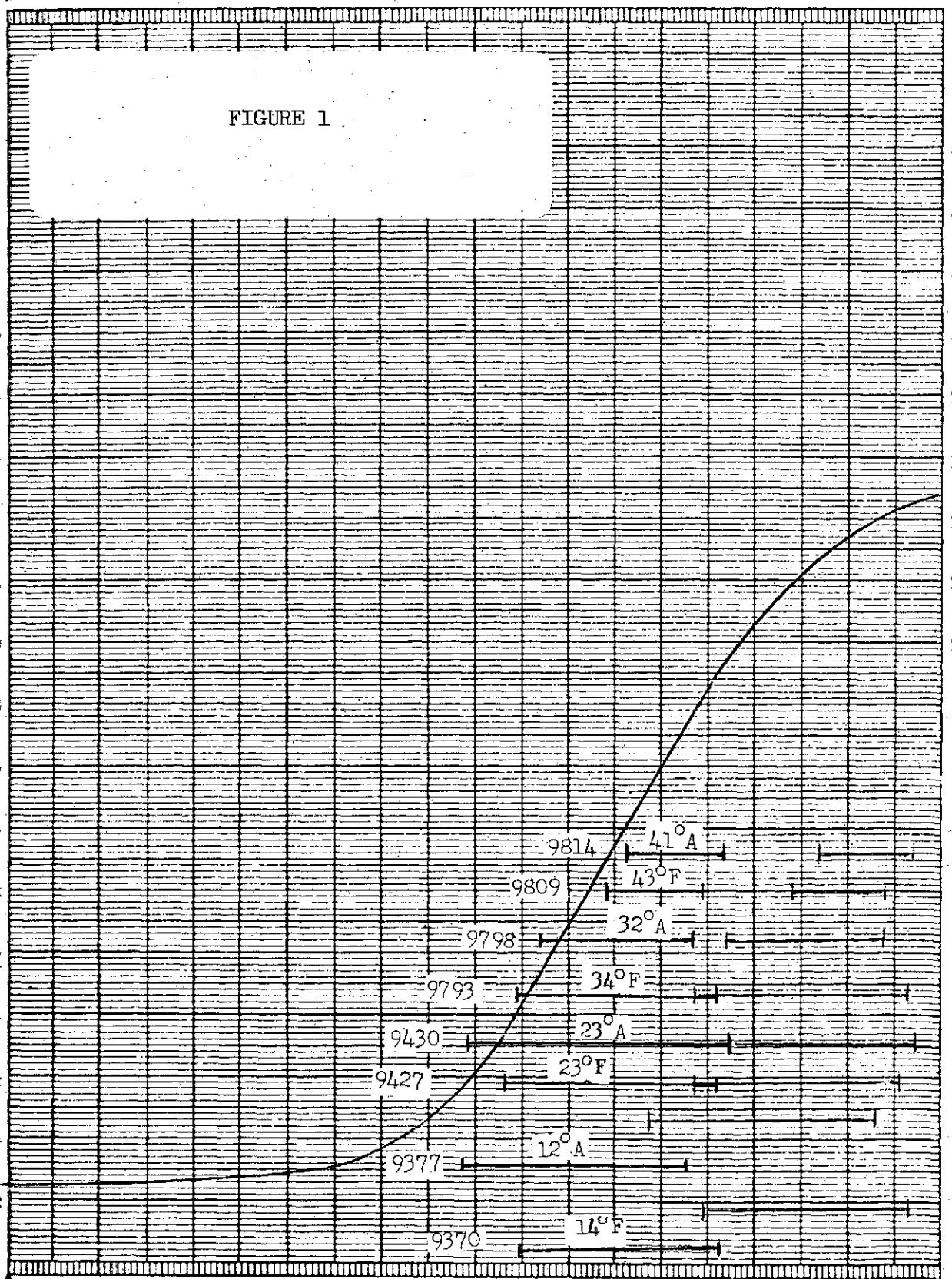
FIGURE 1



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

7.67 -10

T71-21

DATE _____ CONTROL # _____ TASK Apollo 15 PREPARED BY G.M.

FILM 3414 EMULSION # _____ MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER _____	PROCESSOR _____	INSTRUMENT _____ SPEED ( ) _____
ILLUMINANT _____ °K	CHEMISTRY _____	TYPE _____ D-MAX _____
TIME _____ SEC.	SPEED _____ TANKS _____ FPM	APERTURE SIZE _____ MM GAMMA _____
FILTER 4750°K.	TEMP °F _____ TIME _____	FILTER _____ BASE + FOG _____

CHEMICAL ANALYSIS

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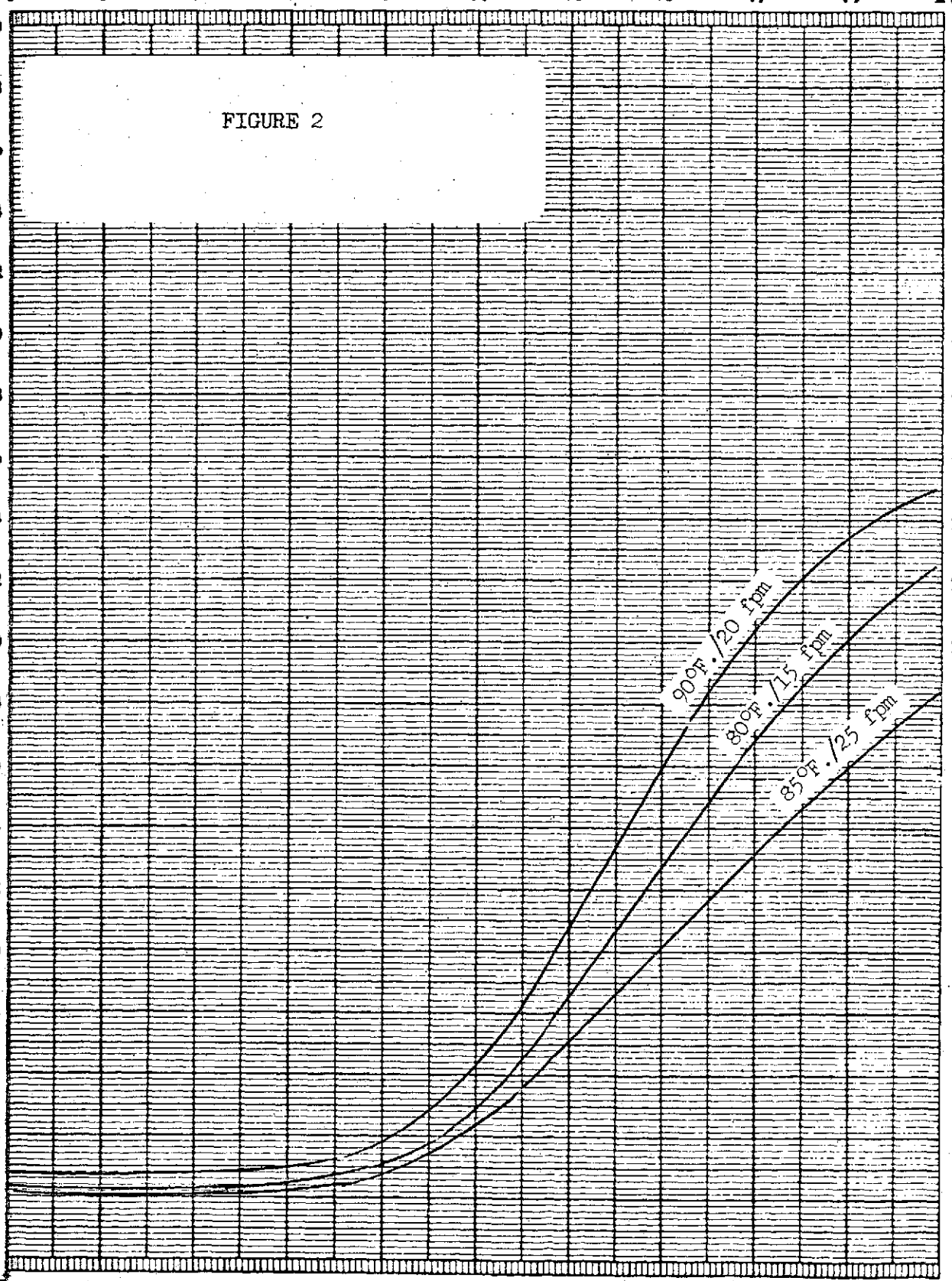
FIGURE 2



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APPENDIX

Time/Temperature Processing Curves for Film Type 3414

DATE 4-24-72 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 3414 EMULSION # 16-5 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER IB	PROCESSOR FULTRON	INSTRUMENT TD403 / SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-819	TYPE DD / D-MAX
TIME 5 SEC.	SPEED ___ TANKS 10-25 FPM	APERTURE SIZE 4 MM / GAMMA
FILTER 4750°K	TEMP °F 80° TIME ___	FILTER VISUAL / BASE + FOG

CHEMICAL ANALYSIS

SP GR

pH

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TRP

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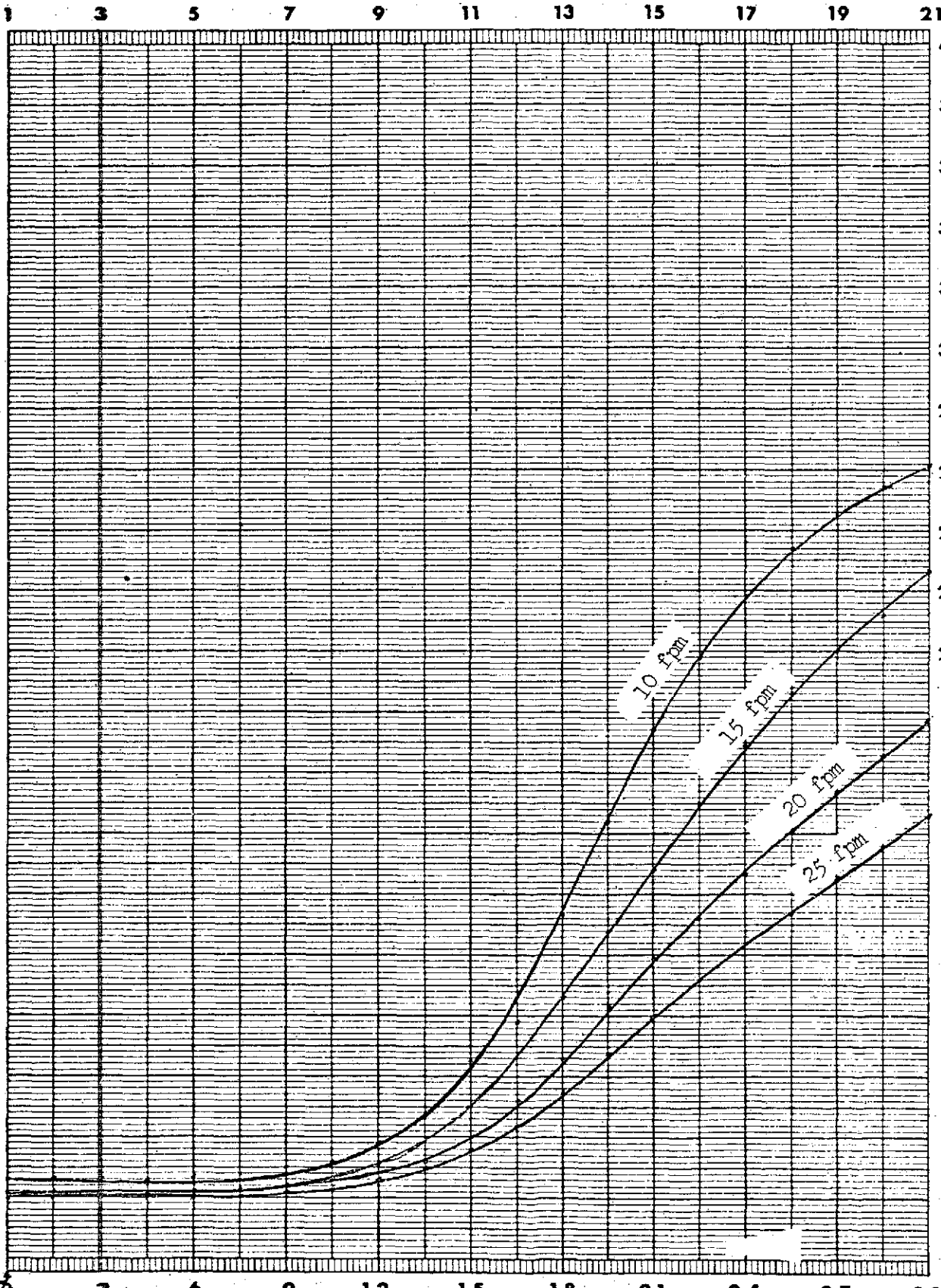

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DATE 4-24-72 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 3414 EMULSION # 16-5 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER IB	PROCESSOR FULTON	INSTRUMENT TD403
ILLUMINANT 2850 °K	CHEMISTRY MX-819	TYPE DD
TIME 1/25 SEC.	SPEED _____ TANKS 10-25 FPM	APERTURE SIZE 4 MM
FILTER 4750 °K	TEMP °F 85 TIME _____	FILTER VISUAL

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

CHEMICAL ANALYSIS

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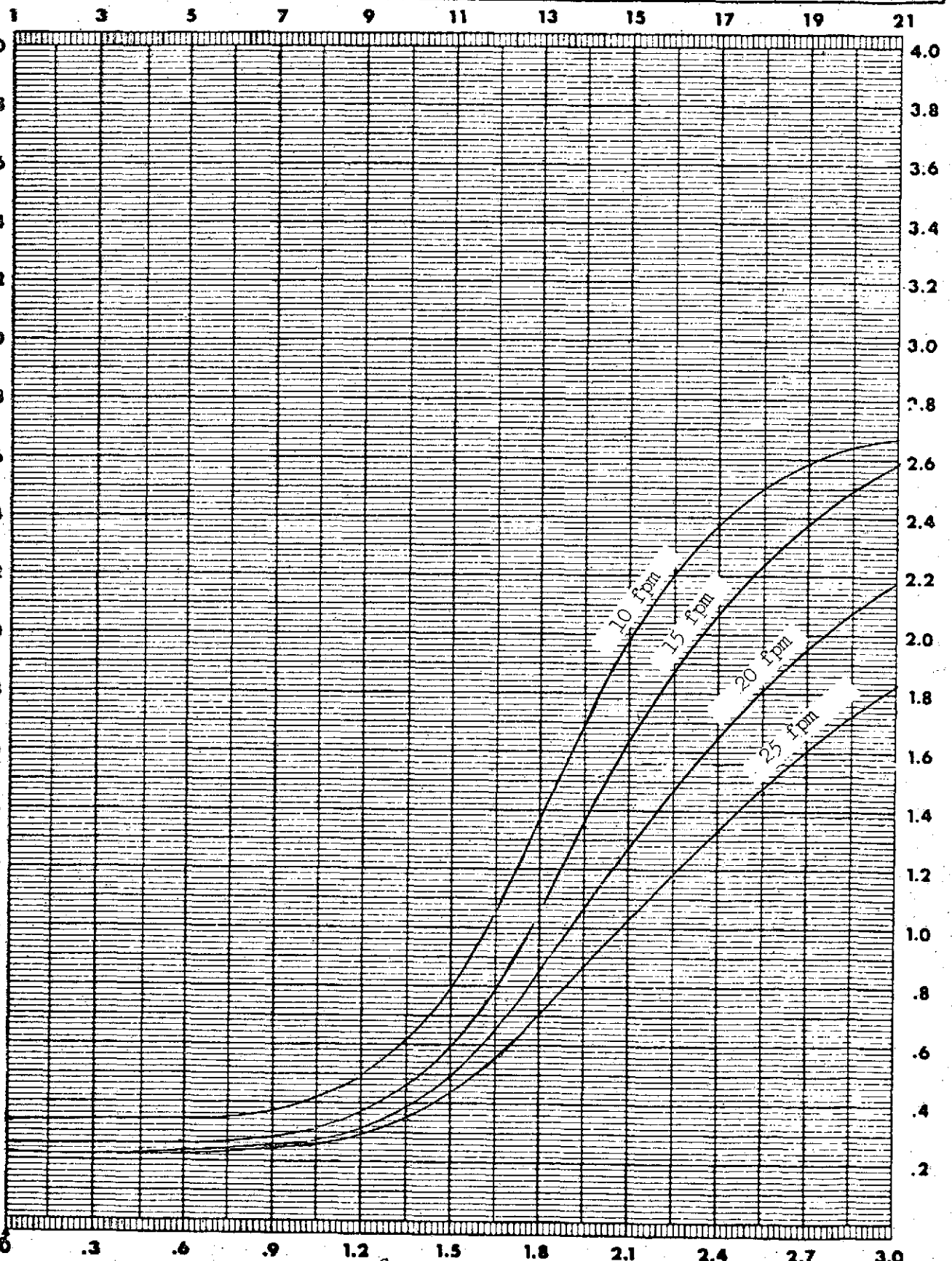

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DATE 4-24-72 CONTROL # _____ TASK Time Gamma PREPARED BY J

FILM 3414 EMULSION # 16-5 MFG E.K.Co EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER IB	PROCESSOR FULTRON #2	INSTRUMENT TD403 / SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX819	TYPE DD / D-MAX
TIME 1/25 SEC.	SPEED FULL TANKS 10-25 FPM	APERTURE SIZE 4 MM / GAMMA
FILTER 4750	TEMP °F 90 TIME	FILTER VISUAL / BASE + FOG

CHEMICAL ANALYSIS

SP GR

pH

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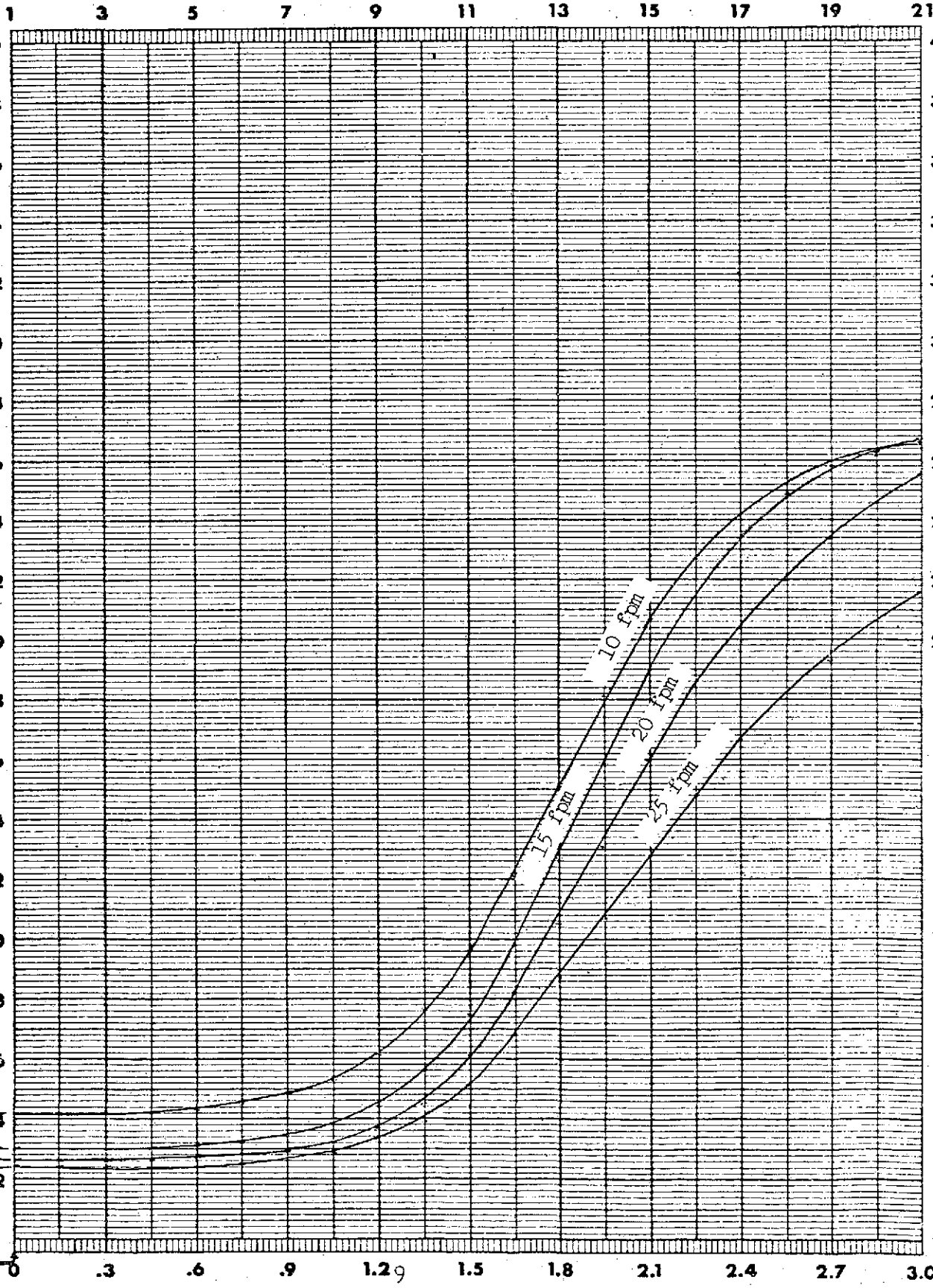

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10 FPM
15 FPM
20 FPM
25 FPM

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

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DATE 4-24-72 CONTROL # _____ TASK Time Gamma PREPARED BY JE

FILM 3414 EMULSION # 16-5 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER 1B	PROCESSOR Eastman #2	INSTRUMENT TD403
ILLUMINANT 2850 °K	CHEMISTRY MX 819	TYPE DD
TIME 1/25 SEC.	SPEED Full TANKS 16.25 FPM	APERTURE SIZE 9 MM
FILTER 4750	TEMP °F 95 TIME _____	FILTER Visual
		SPEED ( ) _____
		D-MAX _____
		GAMMA _____
		BASE + FOG _____

CHEMICAL ANALYSIS

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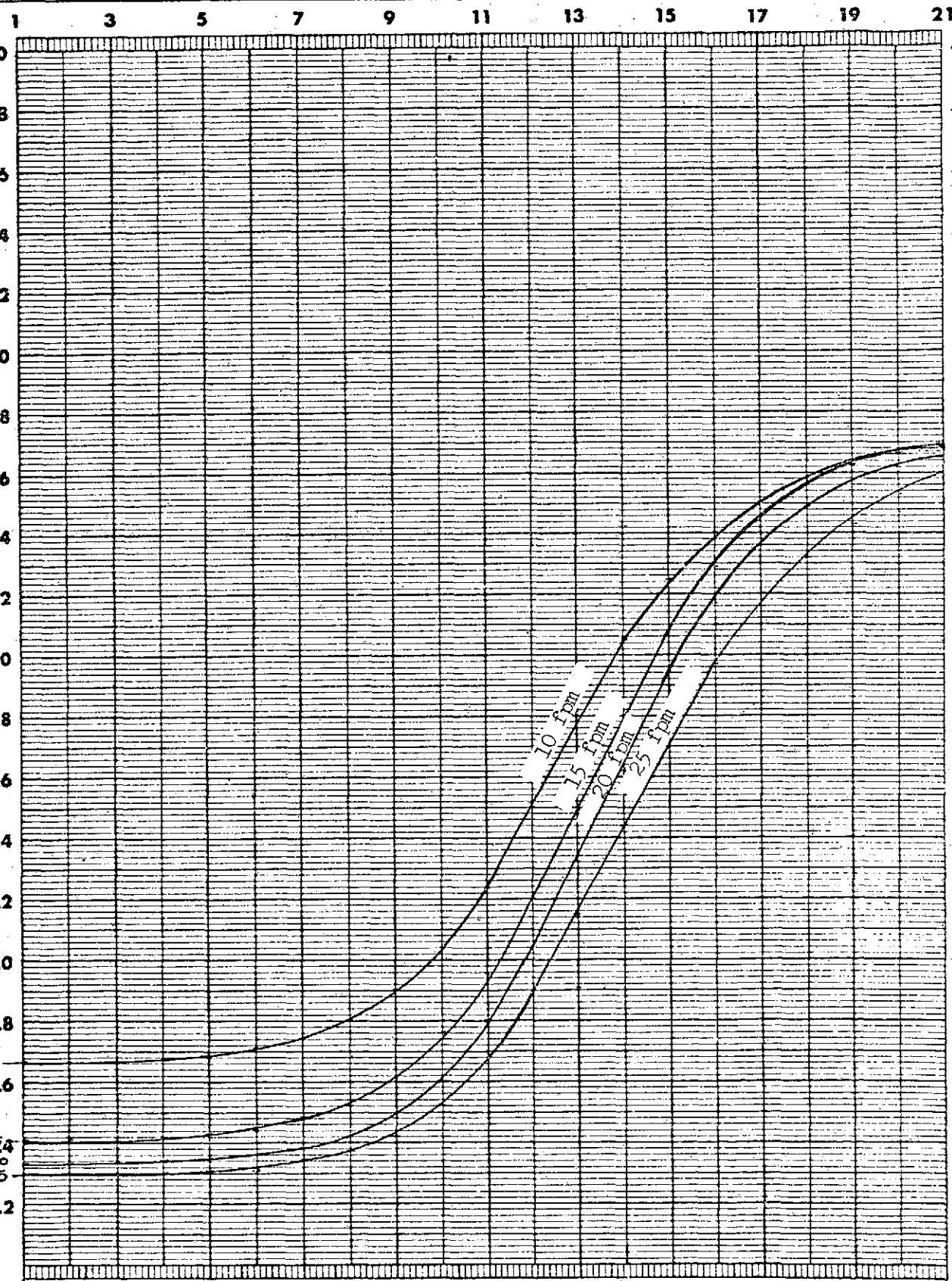

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DATE 4-24-72 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 3414 EMULSION # 16-5 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER IB	PROCESSOR FULTRON	INSTRUMENT TD403 / SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX-819	TYPE DD / D-MAX
TIME 1/5 SEC.	SPEED ___ TANKS 10-75 FPM	APERTURE SIZE 4 MM / GAMMA
FILTER 4750°K	TEMP °F 80 TIME ___	FILTER VISUAL / BASE + FOG

CHEMICAL ANALYSIS

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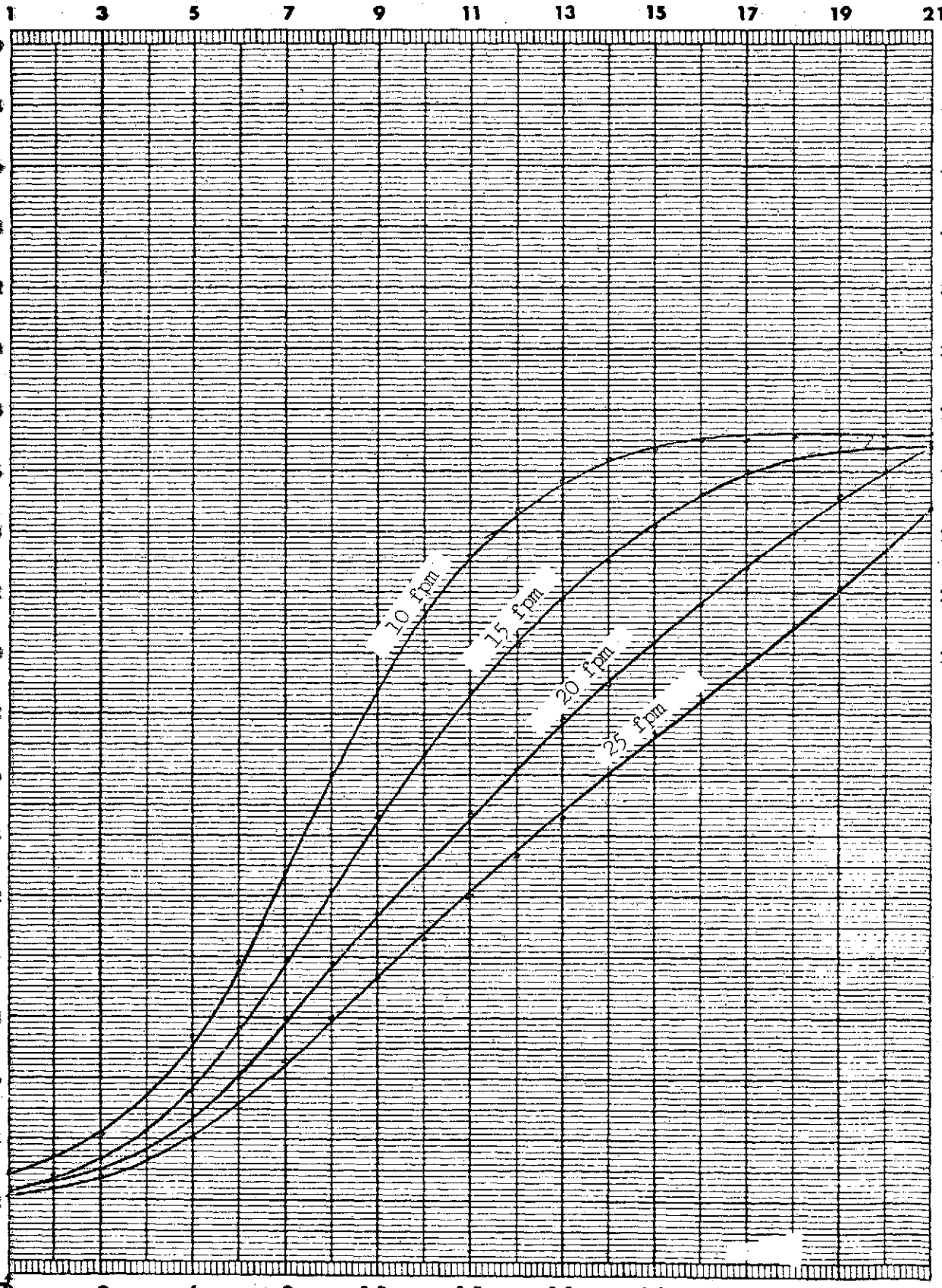

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ABSOLUTE LOG E AT R.L.E. = 0

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DATE 4-24-72 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 3414 EMULSION # 16-5 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA		PROCESSING DATA		DENSITOMETRY	
SENSITOMETER	1B	PROCESSOR	FULTRON	INSTRUMENT	TD403
ILLUMINANT	2850 °K	CHEMISTRY	MX-819	TYPE	DD
TIME	1/2 SEC.	SPEED	FULL TANKS 10-25 FPM	APERTURE SIZE	4 MM
FILTER	4750	TEMP °F	85 TIME	FILTER	VISUAL
				SPEED ( )	
				D-MAX	
				GAMMA	
				BASE + FOG	

CHEMICAL ANALYSIS

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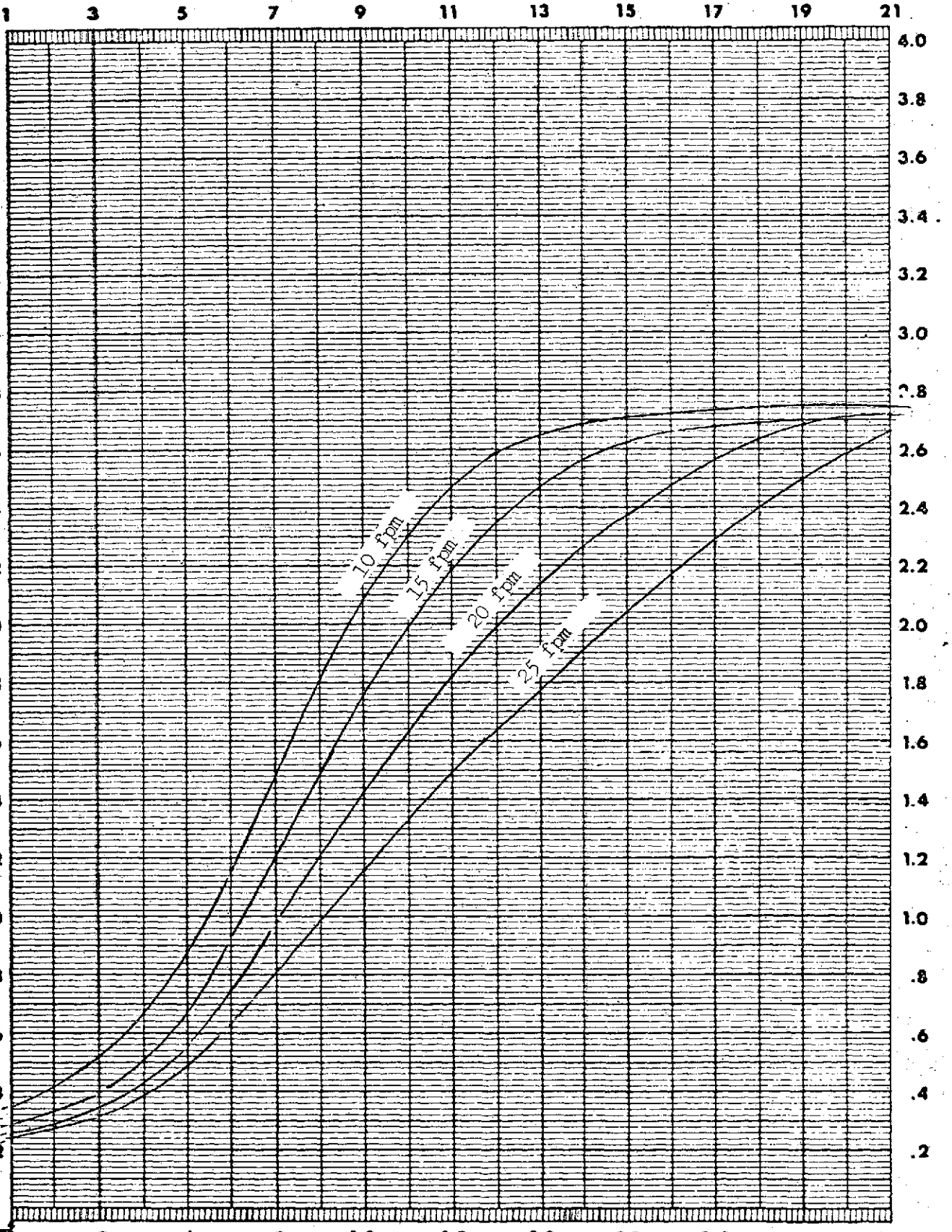

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DATE 4-24-72 CONTROL # _____ TASK TIME Gamma PREPARED BY JE

FILM 3414 EMULSION # 16-5 MFG EKCo EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER IB	PROCESSOR FULTRON #2	INSTRUMENT TDAD3
ILLUMINANT 2850 °K	CHEMISTRY MX819	TYPE DD
TIME 1/2 SEC.	SPEED FULL TANKS 10-25 FPM	APERTURE SIZE 4 MM
FILTER 4750	TEMP °F 90° TIME _____	FILTER VISUAL

DENSITOMETRY: SPEED ( ) _____ D-MAX _____ GAMMA _____ BASE + FOG _____

CHEMICAL ANALYSIS

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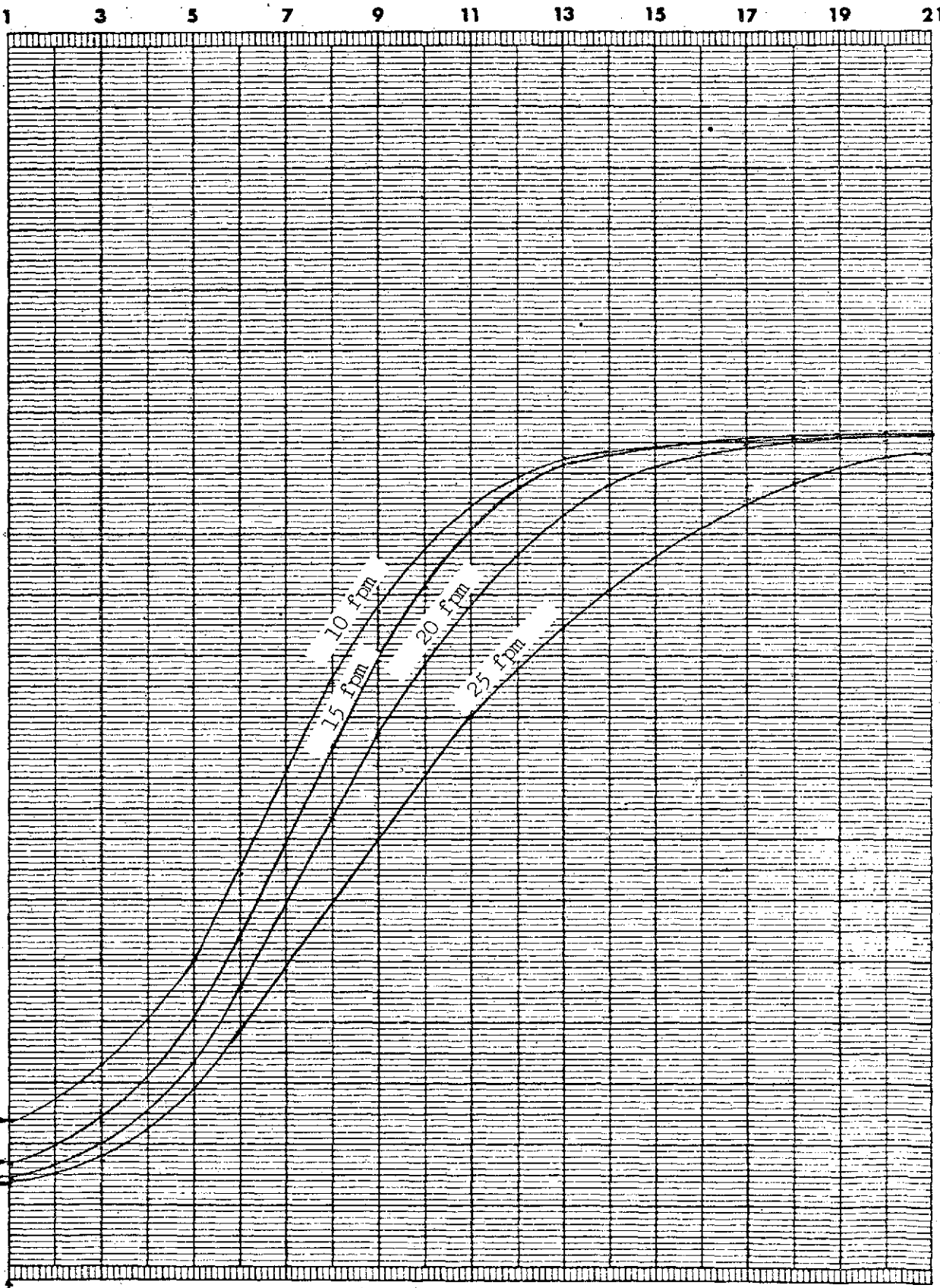

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DATE 4-24-72 CONTROL # _____ TASK Time Gamma PREPARED BY _____

FILM 3414 EMULSION # 16-5 MFG EK Co EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER 1B	PROCESSOR FULTRON #2	INSTRUMENT TD 403 / SPEED ( )
ILLUMINANT 2850 °K	CHEMISTRY MX 819-1	TYPE DD / D-MAX
TIME 1/2 SEC.	SPEED FULL TANKS 10 25 FPM	APERTURE SIZE 4 MM / GAMMA
FILTER ~~4750~~ 4750	TEMP °F 95 TIME	FILTER VISUAL / BASE + FOG

CHEMICAL ANALYSIS

SP GR

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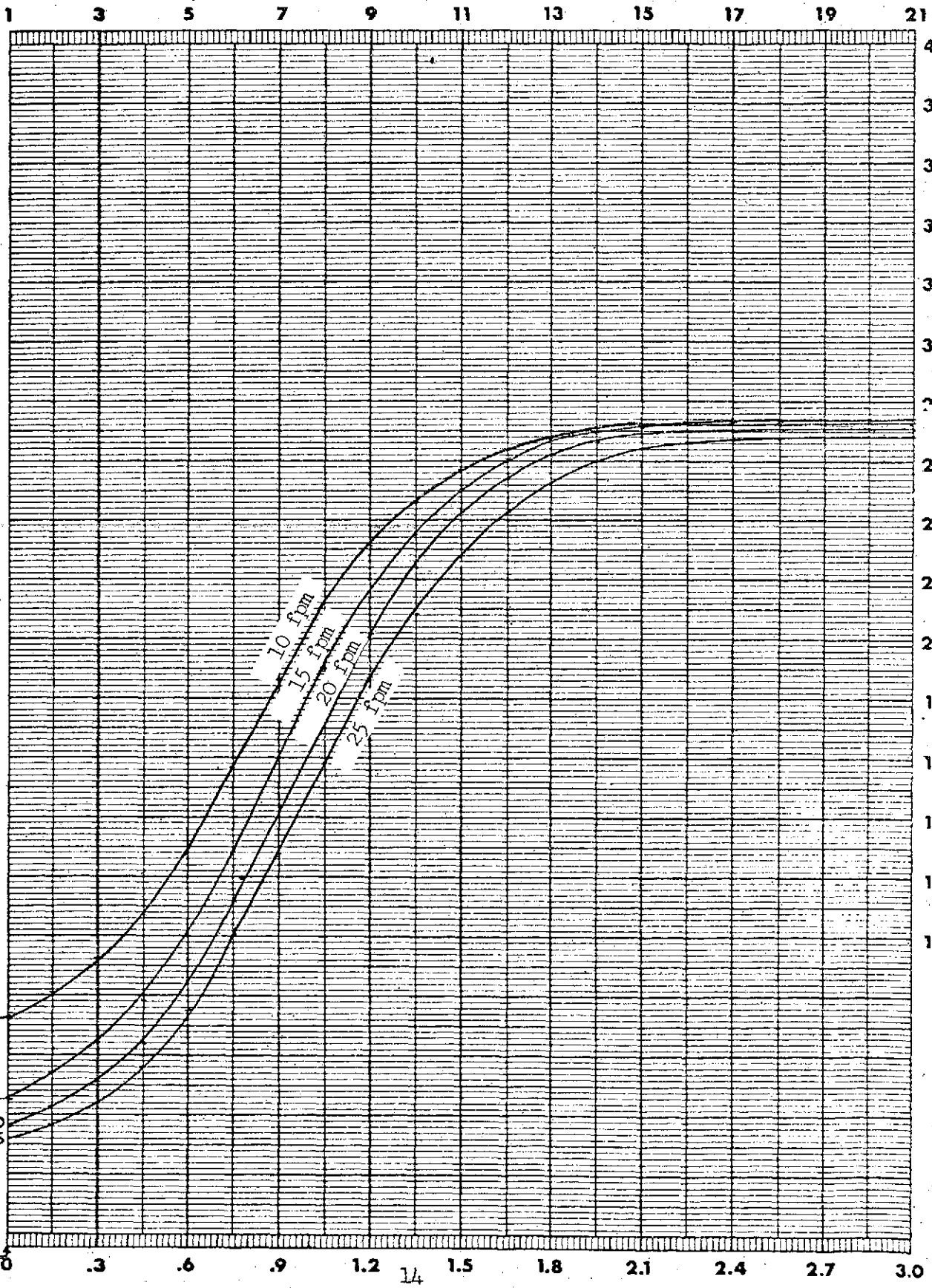

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ABSOLUTE LOG E AT R.L.E. = 0

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