ANALYSIS OF DUPONT AND KODAK DUPLICATING FILMS AND CHEMISTRIES IN A FULTRON SPRAY PROCESSOR

This Report has been reviewed

and is approved.

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ABSTRACT

This report describes a test program conducted with duPont duplicating film type SR 112 and SCOlOR developer and Kodak duplicating film types 2430, 2422, and FE 2628 (SO-467) and MX-641 developer to determine sensitometric and image quality characteristics of these materials when used with a Fultron Spray Processor.

The test results show that the SCOlOR developer foams excessively in the Fultron Processor when used without any additives and when used with the addition of .05 milliliter of antifoaming agent, tributyl phosphate, per liter of SCOlOR developer.

For the film/process combinations tested, the Kodak type FE 2628 film with MX-641 chemistry had the longest linear Log E range at a 1.0 gamma.

Sensitometric curves and granularity traces for all film/process combinations tested are included in the appendices.

INTRODUCTION

The duplication of photographic films is an especially critical task for the Photographic Technology Division (PTD), since most of the scientific investigations are conducted not with the original imagery, but with various generation copies.

The Photographic Science Office is, therefore, continually searching for new duplicating materials and techniques to insure that the duplicate imagery distributed by the PTD is of the highest possible quality.

One of the major problems confronting the Precision Laboratory is that of obtaining a high resolution duplicating material capable of producing a gamma of 1.0 with a linear Log E range of at least 1.4 using a chemistry compatible with the Fultron Spray Processors. This requirement comes about primarily because of the large density range encountered on much of the lunar imagery. A search was instituted for new duplicating materials capable of meeting the described parameters.

On January 4, 1972, representatives of the Photographic Science Office and the Precision Laboratory met with representatives of the E. I. duPont de Nemours & Company, Inc., to discuss their duplication materials. Two films, types CRN and SR 112, were described which appeared to offer advantages in latitude and

resolution over those materials presently being used. The film type CRN is a direct reversal material similar to Kodak film type 2422, but is claimed to have a longer linear Log E range. Film type SR 112 is a negative type duplicating film with sensitometric characteristics similar to Kodak film type 2420. The recommended developer for these films is duPont SCOLOR. However, this developer had never been used in a Fultron Spray Processor. The PTD requested that duPont supply eight 5 inch by 500 foot rolls of each film type and 500 gallons of SCOLOR developer for testing in the Fultron Processor.

Shortly thereafter, Kodak informed the PTD of a new experimental duplicating film similar to 2420 but with a longer linear Log E range and improved MTF characteristics. This film was called FE 2628 at the time, but has since been formally numbered SO-467.

A comprehensive test plan was prepared to evaluate the duPont films and chemistry. This same plan was to be followed using Kodak duplicating materials to provide a basis for comparison. While awaiting arrival of the duPont materials, tests were conducted with Kodak duplicating film types 2430, emulsion batches 178 and 175, and 2422 processed in a Fultron Processor with MX-641 developer.

Considerable difficulty was encountered in obtaining the duPont materials. They were considerably late in arriving at MSC and

when they finally arrived, they were not complete as requested; no CRN material was received and only 60 gallons of SCOLOR developer arrived, as opposed to the 500 gallons requested. This quantity of developer was not nearly enough for evaluation in the Fultron Processor. The original test plan had to be altered and some of the objectives changed to account for a lack of materials and, by now, lack of time. The objectives and test procedures which follow reflect the required revisions.

TEST OBJECTIVES

I. Determine the gamut of sensitometric curves (D Log E) obtainable in a Fultron Processor for all film/chemistry combinations being tested.

II. Determine the image quality characteristics for all film/chemistry combinations being tested.

III. Determine if there are any operational problems in using duPont film type SR 112 with SCOlOR chemistry in a Fultron Processor.

TEST PROCEDURES

I. Prepare a printer loop make up of the following items:

   A. Twenty-one step tablet on Kodak type 3400 film with a nominal .15 density increment between steps.

   B. Twenty-one step, 5 modulation level resolution frisket superimposed on a step tablet made up of steps of Wratten #96 neutral density filters with a nominal .30 density increment between steps.

   C. Five 3 inch by 3 inch Wratten #96 neutral density patches with nominal density values of 0.3, 0.6, 0.9, 1.2, and 1.5.

   D. Samples of pan and metric camera imagery including both high and low phase angle photography.

II. Determine the optimum exposure for duplicating the printer loop in a Niagara Printer with the mercury vapor lamp. Do this for each of the film/process conditions to be tested.

III. Expose one 500-foot rool for each film/process combination with the printer loop in a Niagara Printer using exposure criteria determined in Step II.

IV. Determine proper replenishment rate.

V. Process each film/process combination according to its respective specification except that 1/3 of each roll will be processed at a speed of 10 fpm, the second third at 20 fpm, and the last third at 40 fpm.

VI. Uniformly expose 2000 feet of each film type, so that when processed the nominal density will be 1.0.

VII. Process the exposed film in a Fultron Processor to specifications supplied by the Photo Science Office. Process a sensitometric control strip at 100-foot intervals, along with the 2000 feet of exposed film.

VIII. Expose 15 sensitometric strips from two different emulsion batches (if available) for each film type using the I-B sensitometer. Process the 30 strips from each film type randomly in a Fultron Processor to specifications supplied by the PSO.

IX. Throughout all steps continually be conscious of, and record, operational characteristics, including such problems as foaming, clogging of the spray heads, drying ability, tracking, and contamination.

DISCUSSION

The test procedure was followed first with Kodak duplicating film type 2430, a high resolution negative acting emulsion, and film type 2422, a direct reversal emulsion. Development was carried out in the Fultron Processor using MX-641 chemistry at 68°F. and 80°F. with machine speeds of 10, 20, and 40 feet per minute. Tests were conducted with two different emulsion batches of film type 2430. No problems were encountered during this phase of the testing program. These films and chemistry are normally used by the Precision Laboratory in the Fultron Processor.

The second phase of the testing program commenced with the arrival of film and chemistry from duPont. Two duplicating film types, SR 112, a negative acting emulsion, and CRN, a direct reversal emulsion, were to have been received. Only four 500-foot rolls of the SR 112 film were received initially. An additional four rolls were requested, and they arrived the following day. No CRN material was available. Only 60 gallons of SCOLOR chemistry were received for testing as opposed to the 500 gallons originally requested. The lack of chemistry resulted in an abbreviated test being carried out in the Fultron Processor

The duPont SCOLOR chemistry was mixed in three 20-gallon batches. The resultant chemical analysis, pH and specific gravity (Table 1)

indicates that there is no difference between the three batches.

TABLE 1

duPont SCOLOR Chemical Analysis

Batch	pH	Specific Gravity
1	9.87	1.062
2	9.87	1.063
3	9.87	1.062

As suggested by the duPont representative, Mr. Charles L. Wickham, no antifoaming agent was added initially to the chemistry. duPont had conducted tests with a spray processor and the SCOLOR chemistry that indicated that no antifoaming agent would be required.

Foaming of the developer occurred after about 200 feet of film had been processed. The foaming was of such magnitude that it began flowing out of the developer cabinet door and onto the processing feed elevator and floor of the room. At this point it was decided to add .05 milliliter of antifoaming agent, tributyl phosphate, per liter of SCOLOR developer. The developer was then recirculated for thirty minutes, and another processing cycle was attempted. The same foaming problem occurred again.

Due to the lack of developer solution, no further testing could be done. Subsequent testing of duPont film type SR 112 was carried out in Kodak MX-641 chemistry.

An additional operational problem was noted by the Precision Laboratory. They are of the opinion that the plastic cans the SR 112 film is packaged in would contribute a major handling problem due to the extreme effort required to remove the tops.

No further problems were encountered when using duPont SR 112 film with Kodak MX-641 developer in the Fultron Processor.

The final testing phase was carried out with Kodak film designated by an experimental emulsion, number FE 2628. This film is now produced as a special order item numbered SO-467. Only one 500-foot roll was received. This, however, was sufficient to determine sensitometric characteristics.

TEST RESULTS

Fifteen sensitometric strips exposed in the PTD I-B Precision Sensitometer were read on a MacBeth TD217DR densitometer, averaged, and plotted for each film/process combination tested. The resultant D Log E curves are included in Appendix A. The gamma derived from each curve and a listing of all film/process combinations tested can be found in Table 2.

A sensitometric comparison between the two emulsion batches of Kodak film type 2430 is illustrated in Figures 1 through 6. An examination of these curves shows that no significant sensitometric difference exists between the two emulsion batches.

D Log E curves derived by exposing the film in a Niagara printer using a Film Type 3400 step tablet to modulate the light are plotted and included in Appendix B.

The gamma derived from these plots for duPont film type SR 112 in both SCOLOR and MX-641 developers, and Kodak film type 2430 in MX-641 developer, are included in Table 2. A comparison of the Niagara derived gamma versus the I-B derived gamma shows that the Niagara gamma is lower in all cases but one. This is due primarily to a difference in spectral quality between the

Niagara printer and the Niagara simulation with the I-B sensitometer.

A program developed by Technicolor photoscientist, Bob Goodding, for the Wang 700B Programmable Calculator and Model 702 Plotter was used to provide a plot of the D Log E curve and a plot of the instantaneous slope at each point on the curve superimposed on the same graph. This technique is useful for showing graphically the amount of linearily inherent in the D Log E curve. These curves are included in Appendix C. The curve, displayed as a combination of crosses and dots, is the D Log E curve derived from the average of fifteen I-B sensitometric strips as described previously. The curve, displayed as a series of circles, is a representation of the slope at each point on the D Log E curve. If the D Log E curve was perfectly linear from one end to the other, then the plot of slope would show as a horizontal straight line positioned in the Y-axis at a point equal to the slope of the D Log E curve.

A relative number for linear Log E range was derived from the described slope curve by finding the two points on the curve equal to the maximum slope minus 10%. The Log E distance between these two points is defined as the linear Log E range. This data can be found in Table 2.

To simplify the analysis of the large amount of data collected, the information shown in Table 2 is illustrated graphically in Figures 7, 8, 9, and 10. Figure 7 is a graph of machine speed versus gamma. Figure 8 shows machine speed versus linear Log E range. Figures 9 and 10 illustrate gamma versus linear Log E range for two different temperatures.

Granularity traces were made at four density levels for each film/process combination using a Joyce Loebl microdensitometer with an effective aperture of approximately 23 by 23 microns. These traces are included in Appendix D.

TABLE 2

Film	Chemistry	Process Speed(fpm)	Process Temp(°F.)	I-B Gamma	Niagara Gamma	Linear Log E Range
SR 112	SCOLOR	10	68	1.04	0.81	0.60
SR 112	SCOLOR	20	68	0.61	0.42	0.80
SR 112	SCOLOR	40	68	0.27	0.22	2.40
SR 112	SCOLOR	10	80	1.06	1.09	1.00
SR 112	SCOLOR	20	80	0.72	0.69	1.20
SR 112	SCOLOR	40	80	0.38	0.31	1.65
SR 112	MX-641	10	68	1.38	1.21	0.50
SR 112	MX-641	20	68	1.10	0.94	1.00
SR 112	MX-641	40	68	0.73	0.67	1.75
SR 112	MX-641	10	80	1.40	1.30	0.60
SR 112	MX-641	20	80	1.23	1.12	0.75
SR 112	MX-641	40	80	0.91	0.79	0.75
2430-178	MX-641	10	68	2.13	1.90	0.40
2430-178	MX-641	20	68	1.73	1.45	0.90
2430-178	MX-641	40	68	1.40	1.17	0.75
2430-178	MX-641	10	80	2.06	1.98	0.40
2430-178	MX-641	20	80	2.09	1.98	0.45
2430-178	MX-641	40	80	1.61	1.44	1.10
2430-175	MX-641	10	68	2.22		0.25
2430-175	MX-641	20	68	1.72		1.05
2430-175	MX-641	40	68	1.40		0.75
2430-175	MX-641	10	80	2.10		0.35
2430-175	MX-641	20	80	2.10		0.45
2430-175	MX-641	40	80	1.60		1.10

TABLE 2 (continued)

Film	Chemistry	Process Speed(fpm)	Process Temp(°F.)	I-B Gamma	Niagara Gamma	Linear Log E Range
FE-2628	MX-641	10	68	1.60		0.70
FE-2628	MX-641	20	68	1.19		0.80
FE-2628	MX-641	40	68	0.86		2.00
FE-2628	MX-641	10	80	1.77		0.60
FE-2628	MX-641	20	80	1.46		0.70
FE-2628	MX-641	40	80	1.01		1.20

DATE _____ CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # 178 175 _____ MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER _____	PROCESSOR _____	INSTRUMENT _____	SPEED ( ) _____
ILLUMINANT _____ °K	CHEMISTRY _____	TYPE _____	D-MAX _____
TIME _____ SEC.	SPEED _____ TANKS 10 FPM	APERTURE SIZE _____ MM	GAMMA _____
FILTER _____	TEMP °F 68 TIME _____	FILTER _____	BASE + FOG _____

CHEMICAL ANALYSIS

_____ SP GR

_____ pH

_____ TA

_____ TRP

_____ KB_r

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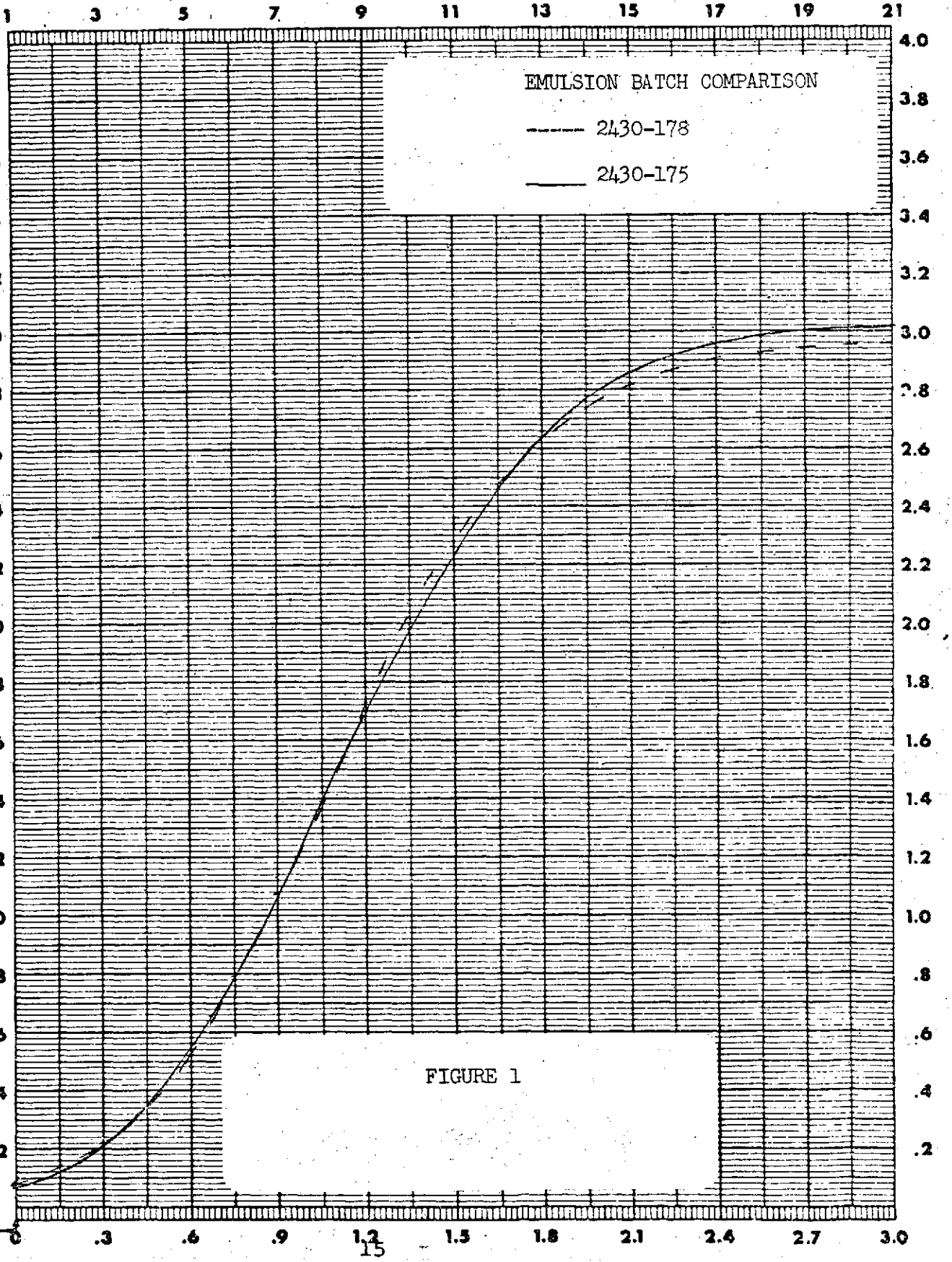

FIGURE 1

Technicolor

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

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71-21

DATE _____ CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # 178 / 175 _____ MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER _____	PROCESSOR _____	INSTRUMENT _____	SPEED ( ) _____
ILLUMINANT _____ K	CHEMISTRY _____	TYPE _____	D-MAX _____
TIME _____ SEC.	SPEED _____ TANKS 20 FPM	APERTURE SIZE _____ MM	GAMMA _____
FILTER _____	TEMP °F 68 TIME _____	FILTER _____	BASE + FOG _____

CHEMICAL ANALYSIS

_____ SP GR

_____ pH

_____ TA

_____ TRP

_____ KB_r

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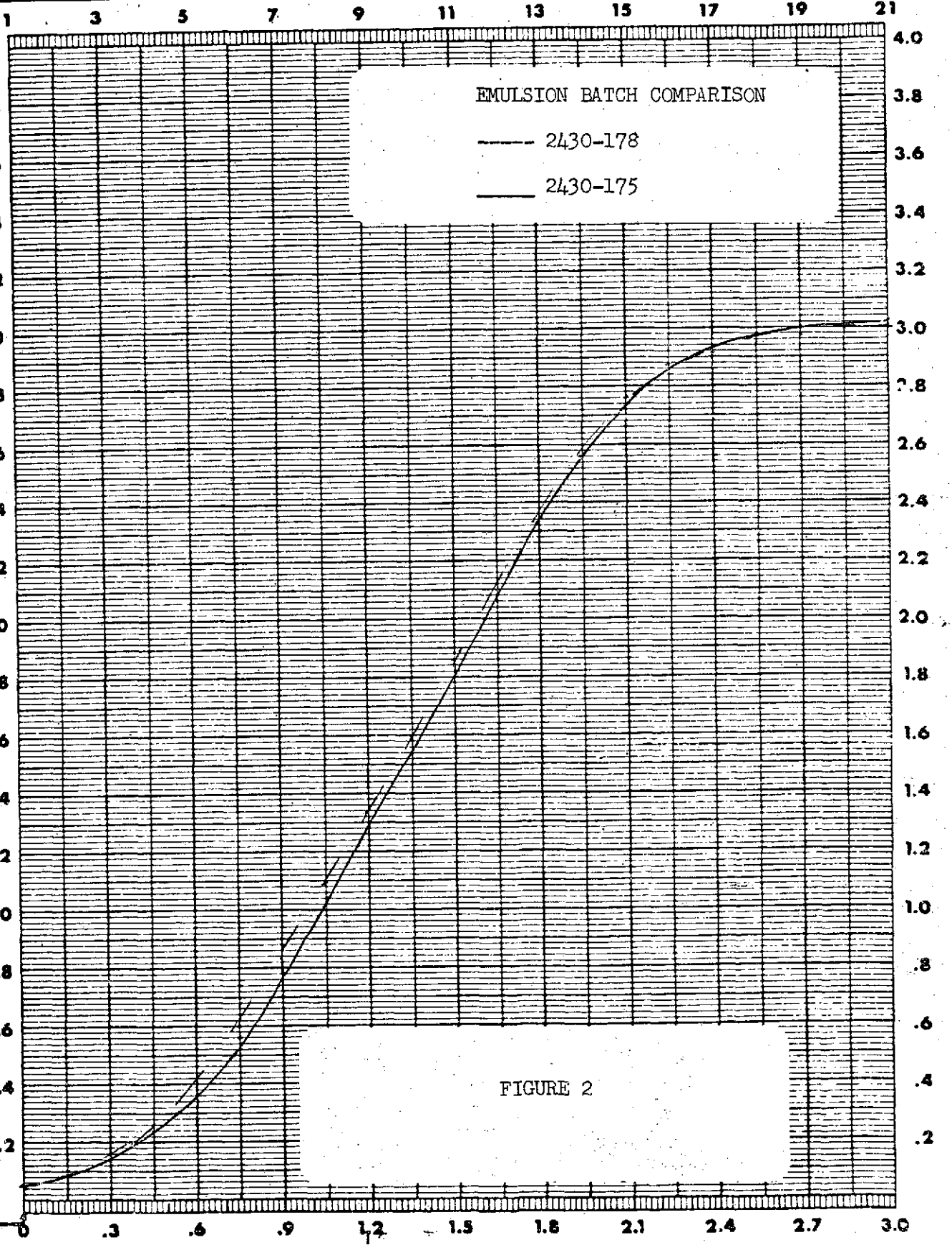

FIGURE 2

Technicolor

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

_____ −10

DATE _____ CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # 178 175 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER _____	PROCESSOR _____	INSTRUMENT _____ SPEED ( ) _____
ILLUMINANT _____ °K	CHEMISTRY _____	TYPE _____ D-MAX _____
TIME _____ SEC.	SPEED _____ TANKS 40 FPM	APERTURE SIZE _____ MM GAMMA _____
FILTER _____	TEMP °F 68 TIME _____	FILTER _____ BASE + FOG _____

CHEMICAL ANALYSIS

_____ SP GR

_____ pH

_____ TA

_____ TRP

_____ KB_r

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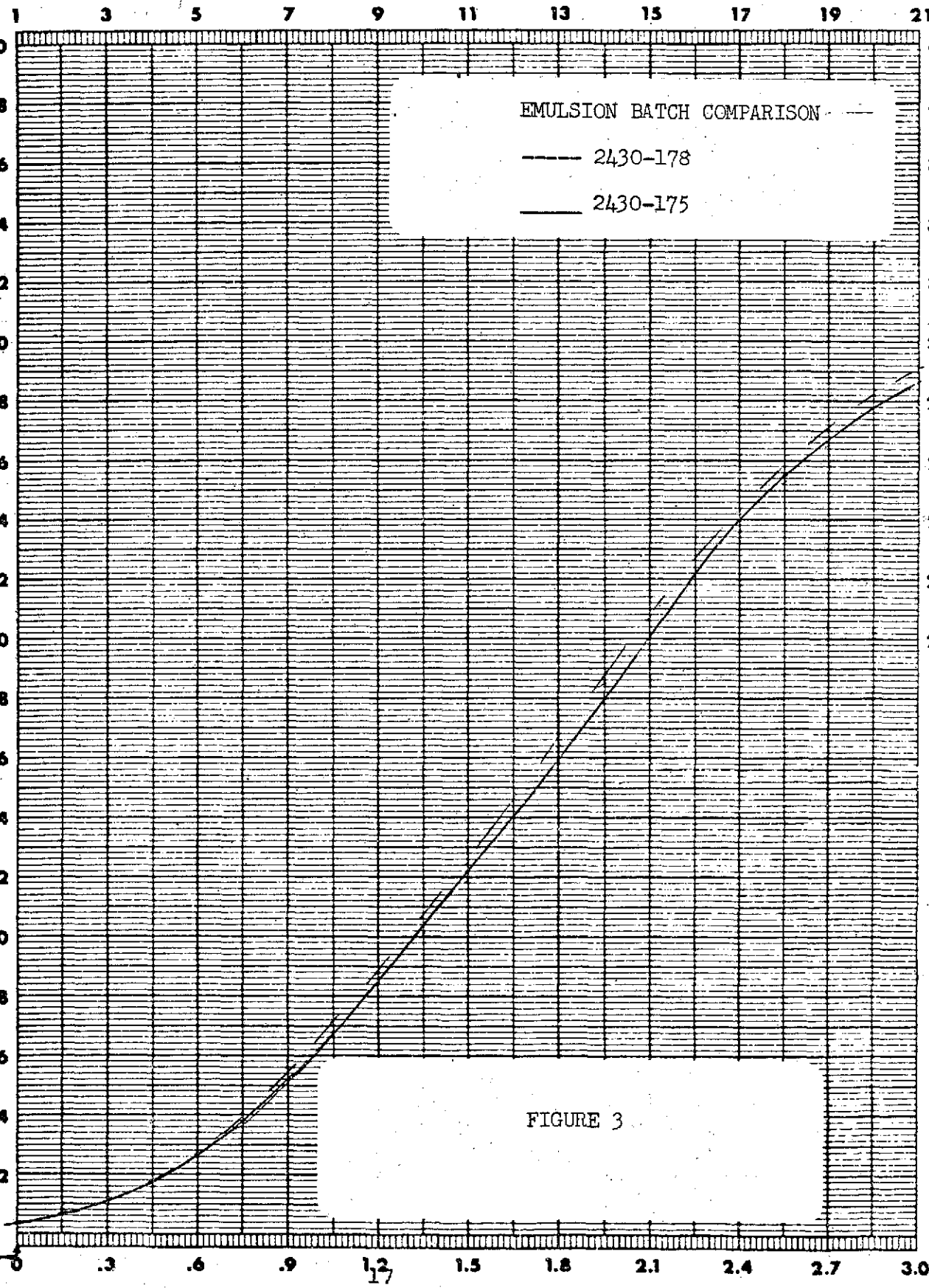

FIGURE 3

Technicolor

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

-10

T71-21

DATE _____ CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # 178 175 _____ MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER _____	PROCESSOR _____	INSTRUMENT _____	SPEED ( ) _____
ILLUMINANT _____ °K	CHEMISTRY _____	TYPE _____	D-MAX _____
TIME _____ SEC.	SPEED _____ TANKS 10 FPM	APERTURE SIZE _____ MM	GAMMA _____
FILTER _____	TEMP °F 80 TIME _____	FILTER _____	BASE + FOG _____

CHEMICAL ANALYSIS

_____ SP GR

_____ pH

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_____ KB_r

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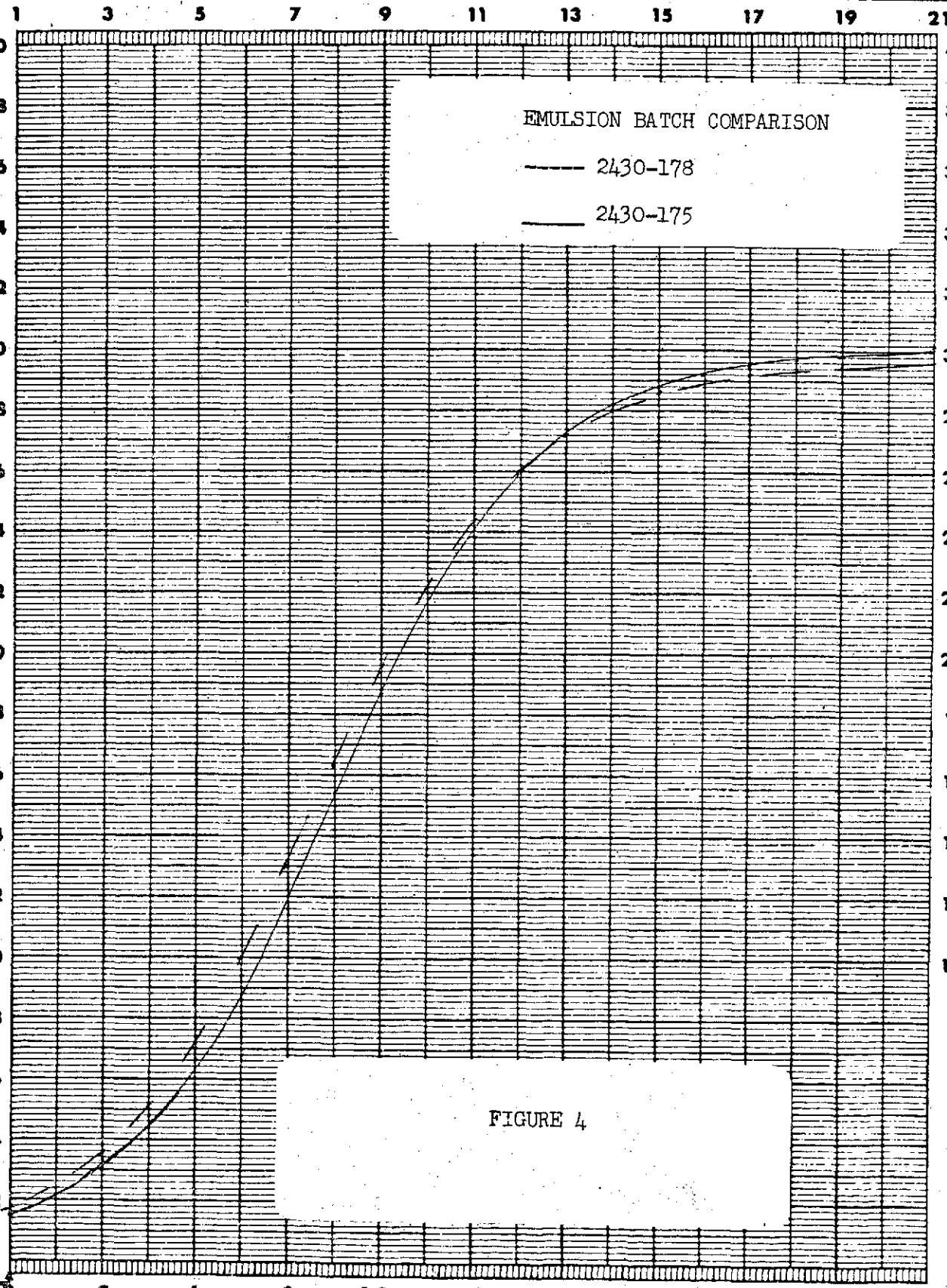

FIGURE 4

Technicolor

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

-10

T71-21

DATE _____ CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # 178 / 175 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER _____	PROCESSOR _____	INSTRUMENT _____	SPEED ( ) _____
ILLUMINANT _____ °K	CHEMISTRY _____	TYPE _____	D-MAX _____
TIME _____ SEC.	SPEED _____ TANKS 20 FPM	APERTURE SIZE _____ MM	GAMMA _____
FILTER _____	TEMP °F 80 TIME _____	FILTER _____	BASE + FOG _____

CHEMICAL ANALYSIS

_____ SP GR

_____ pH

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_____ TPP

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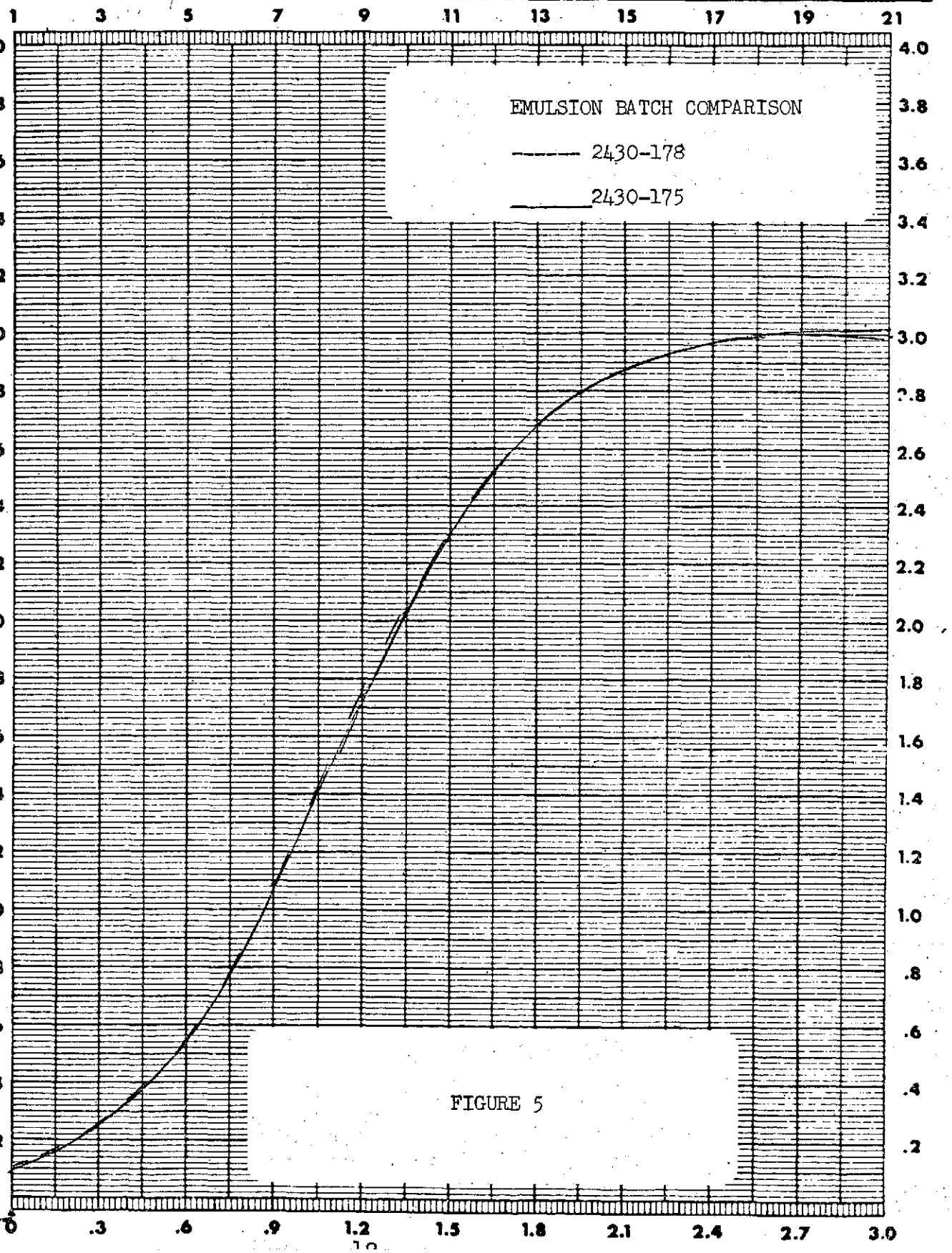

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FIGURE 5

ABSOLUTE LOG E AT R.L.E. - 0 -10

T71-21

DATE _____ CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # 178 175 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER _____	PROCESSOR _____	INSTRUMENT _____	SPEED ( ) _____
ILLUMINANT _____ °K	CHEMISTRY _____	TYPE _____	D-MAX _____
TIME _____ SEC.	SPEED _____ TANKS 40 FPM	APERTURE SIZE _____ MM	GAMMA _____
FILTER _____	TEMP °F 80 TIME _____	FILTER _____	BASE + FOG _____

CHEMICAL ANALYSIS

_____ SP GR

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_____ TPP

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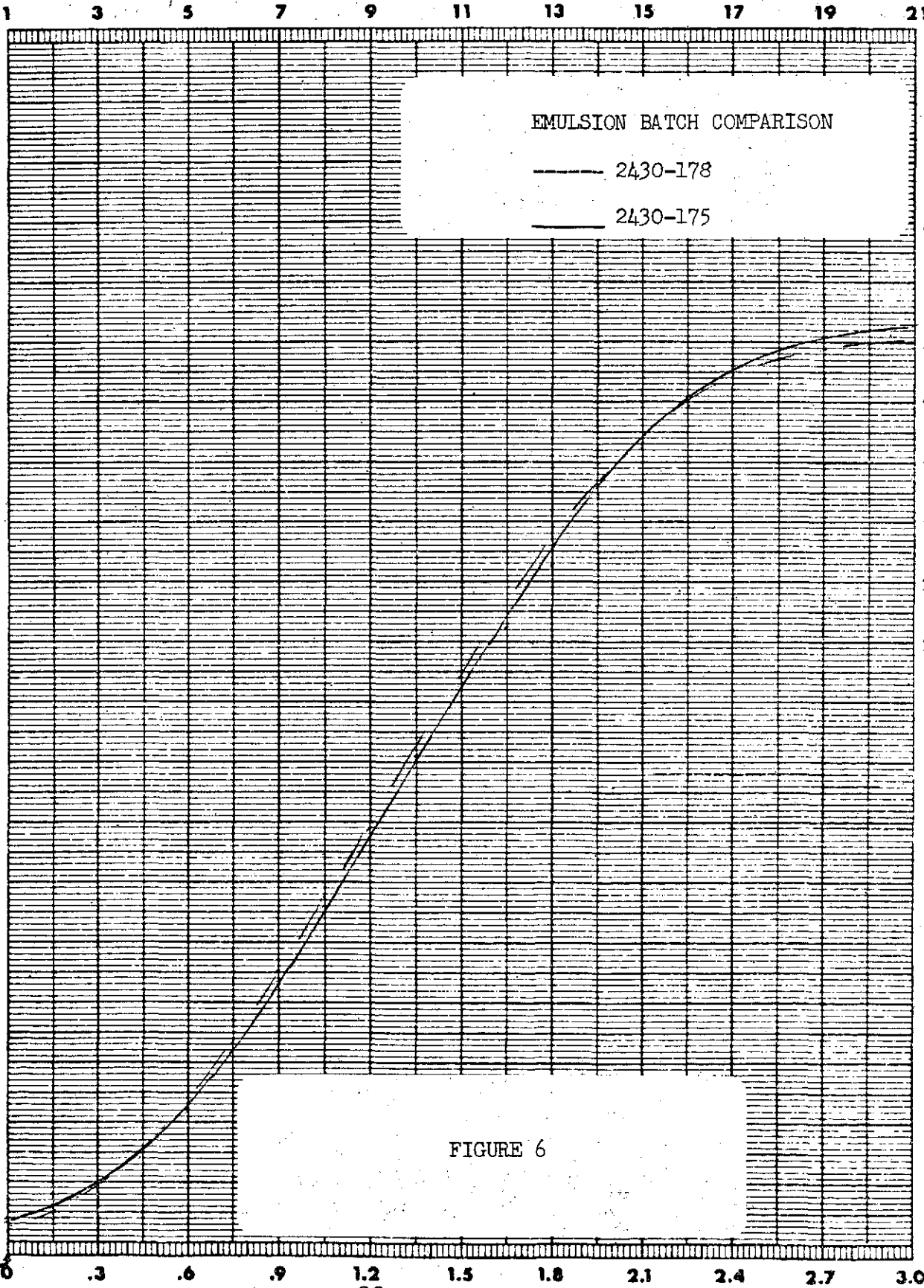

Technicolor

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

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FIGURE 6

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FIGURE 7. Machine Speed vs. Gamma

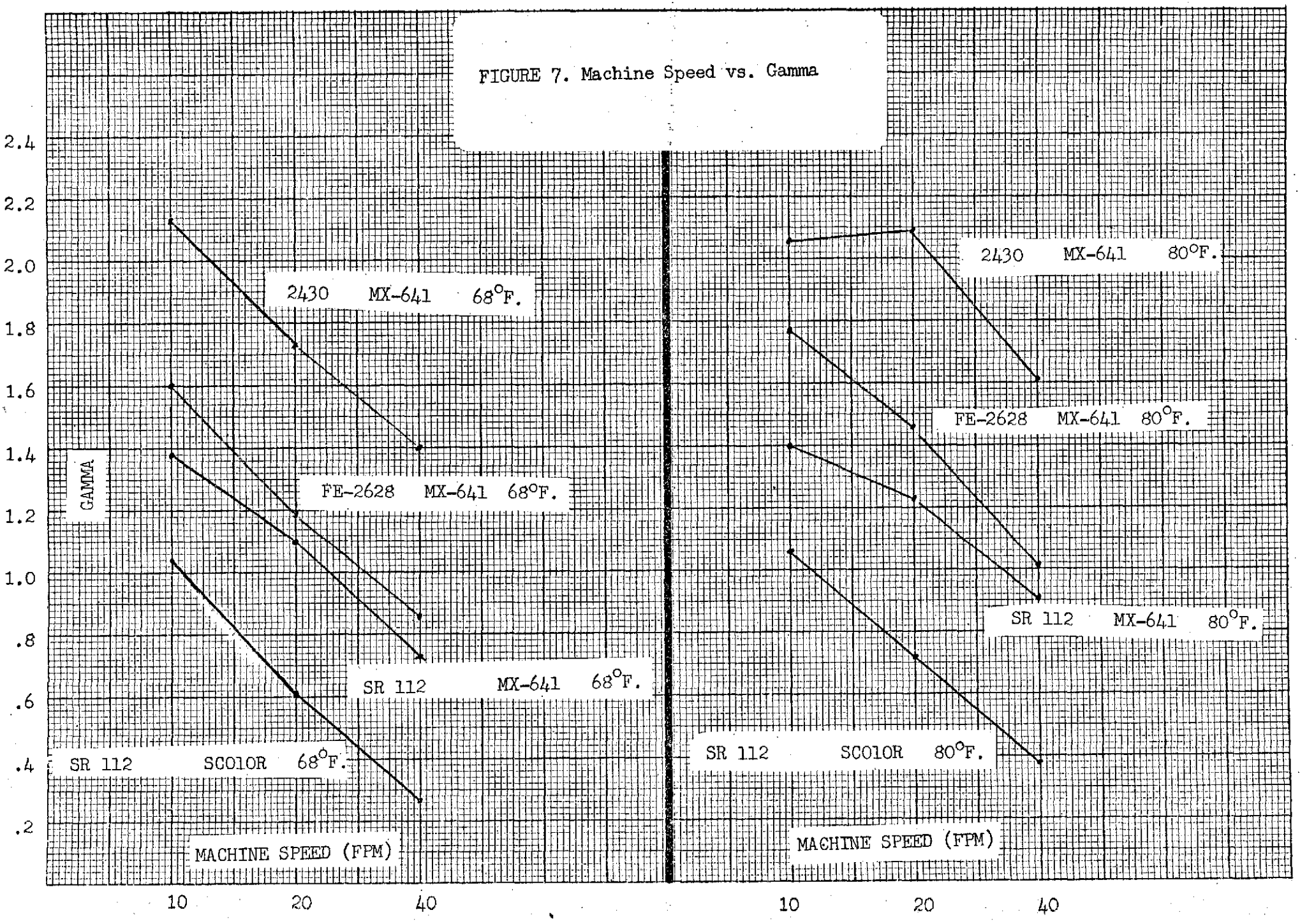


FIGURE 8. Machine Speed vs. Linear Log E Range

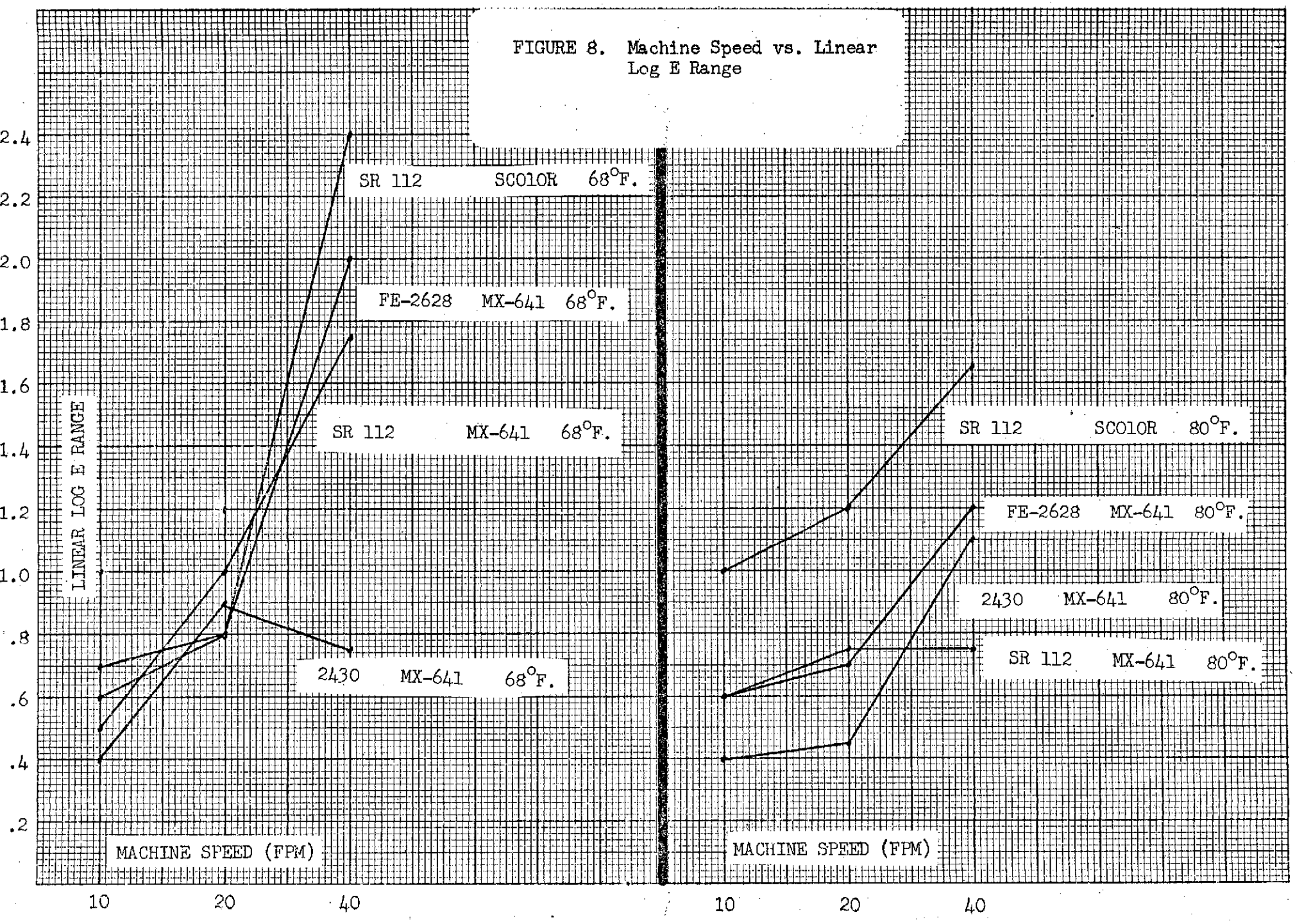


FIGURE 9. Gamma vs. Linear Log E Range (68°F.)

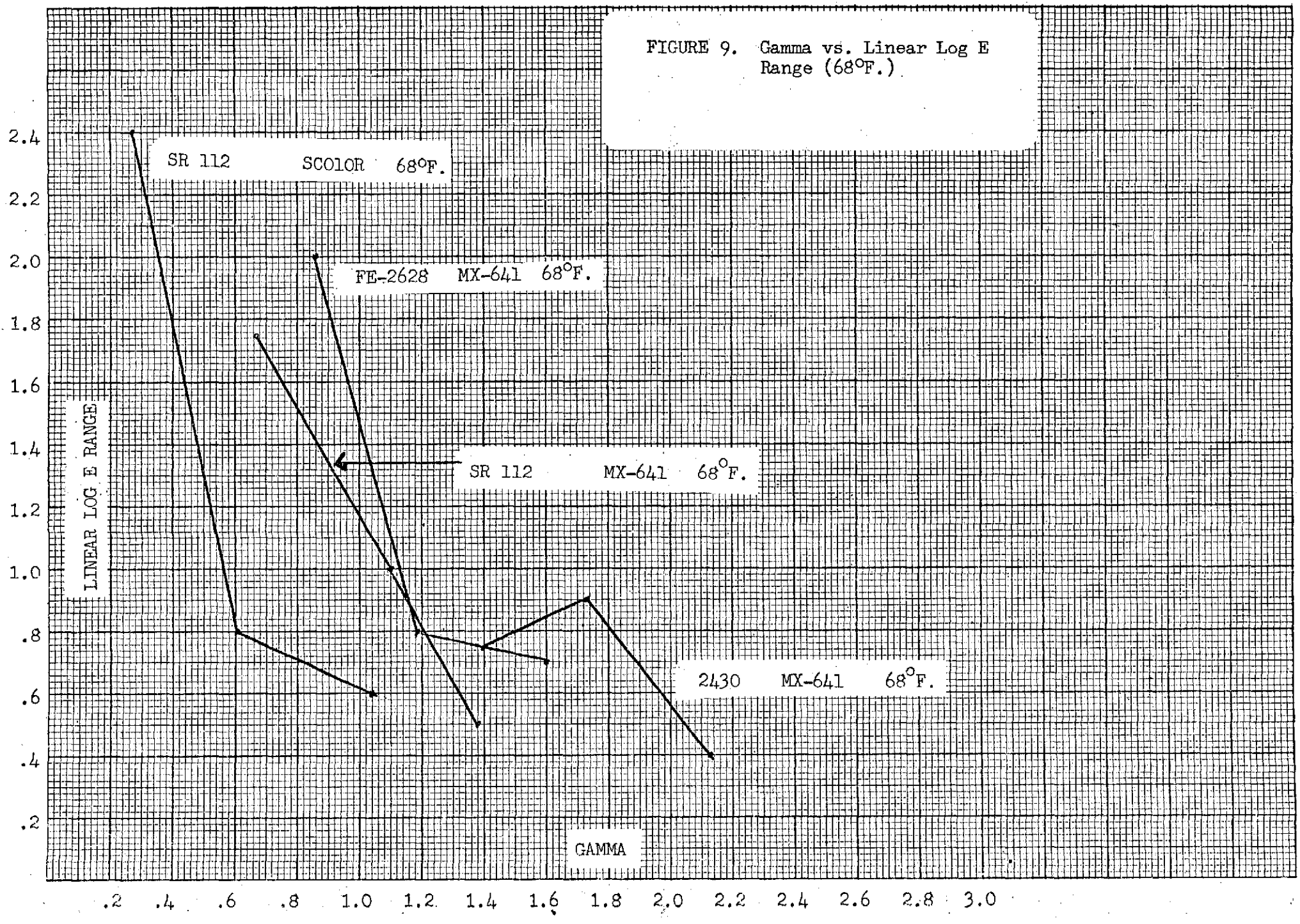
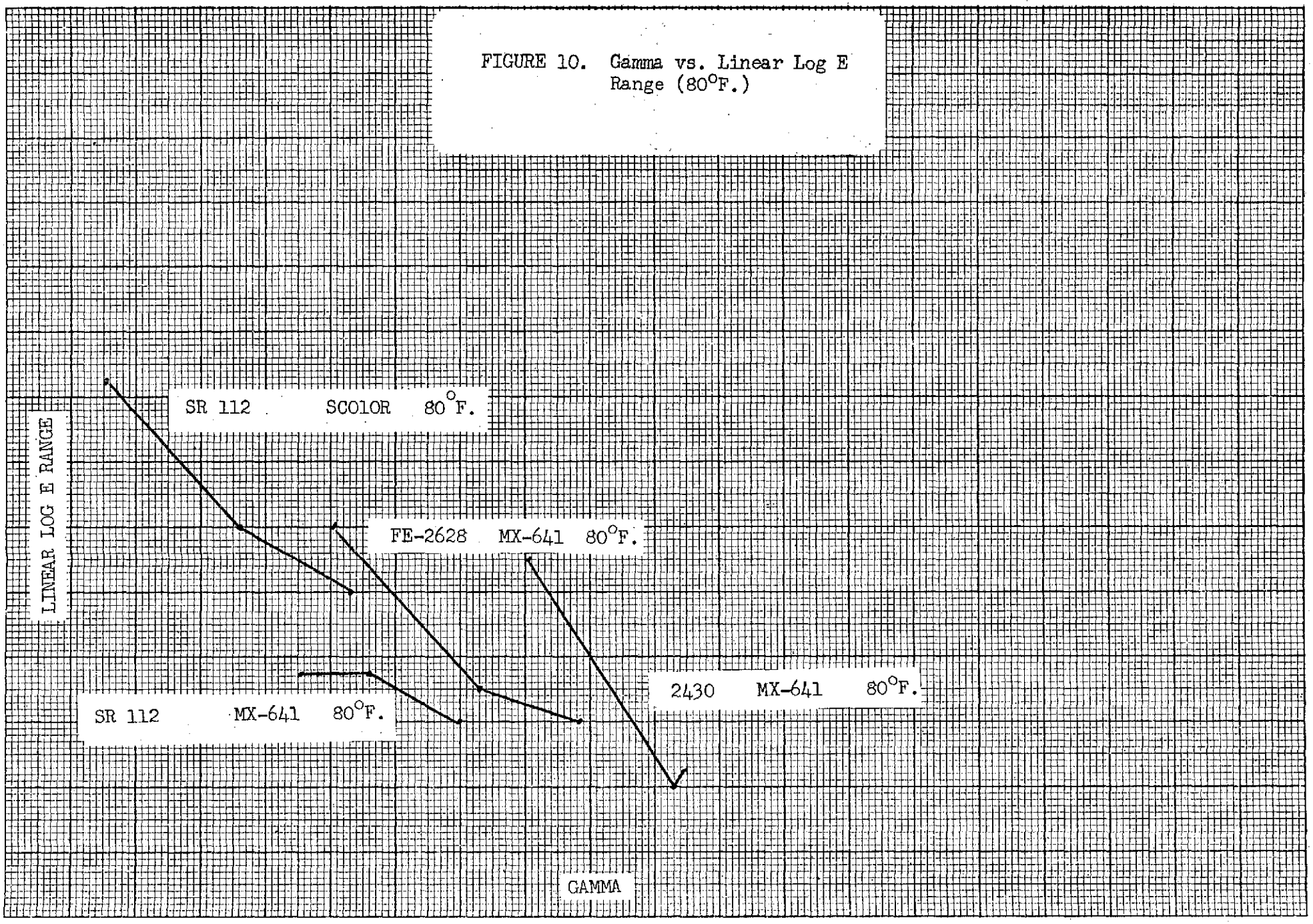


FIGURE 10. Gamma vs. Linear Log E Range (80°F.)



CONCLUSIONS

The duPont SCOlOR Developer foamed excessively in the Fultron Processor when used without any additives and when used with the addition of .05 milliliter of antifoaming agent, tributyl phosphate, per liter of SCOlOR developer.

The film/process combinations tested produced the following range of gammas:

Film	Chemistry	Minimum Gamma	Maximum Gamma
SR 112	SCOlOR	0.27	1.06
SR 112	MX-641	0.73	1.38
2430	MX-641	1.40	2.13
FE 2628	MX-641	0.86	1.77

The film/process combinations tested produced the following maximum linear Log E ranges:

Film	Chemistry	Maximum Linear Log E Range
SR 112	SCOlOR	2.40
SR 112	MX-641	1.75
2430	MX-641	1.10
FE 2628	MX-641	2.00

For the film/process combinations tested, the Kodak film type FE 2628 with MX-641 chemistry had the longest linear Log E range at a 1.0 gamma.

APPENDIX A

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM duPont SR 112 EMULSION # _____ MFG _____ EXPIRATION DATE _____

792-15 EXPOSURE DATA 2489	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B PS6809	PROCESSOR Fultron # 1	INSTRUMENT MacBeth	SPEED ( ) _____
ILLUMINANT 3000 °K	CHEMISTRY SCO 10R	TYPE TD217DR	D-MAX _____
TIME ½ SEC.	SPEED _____ TANKS 10,20,40 FPM	APERTURE SIZE 4 MM	GAMMA _____
FILTER none	TEMP °F 68 TIME _____	FILTER Visual	BASE + FOG _____

CHEMICAL ANALYSIS

SP GR

pH

TA

TRP

KB_r

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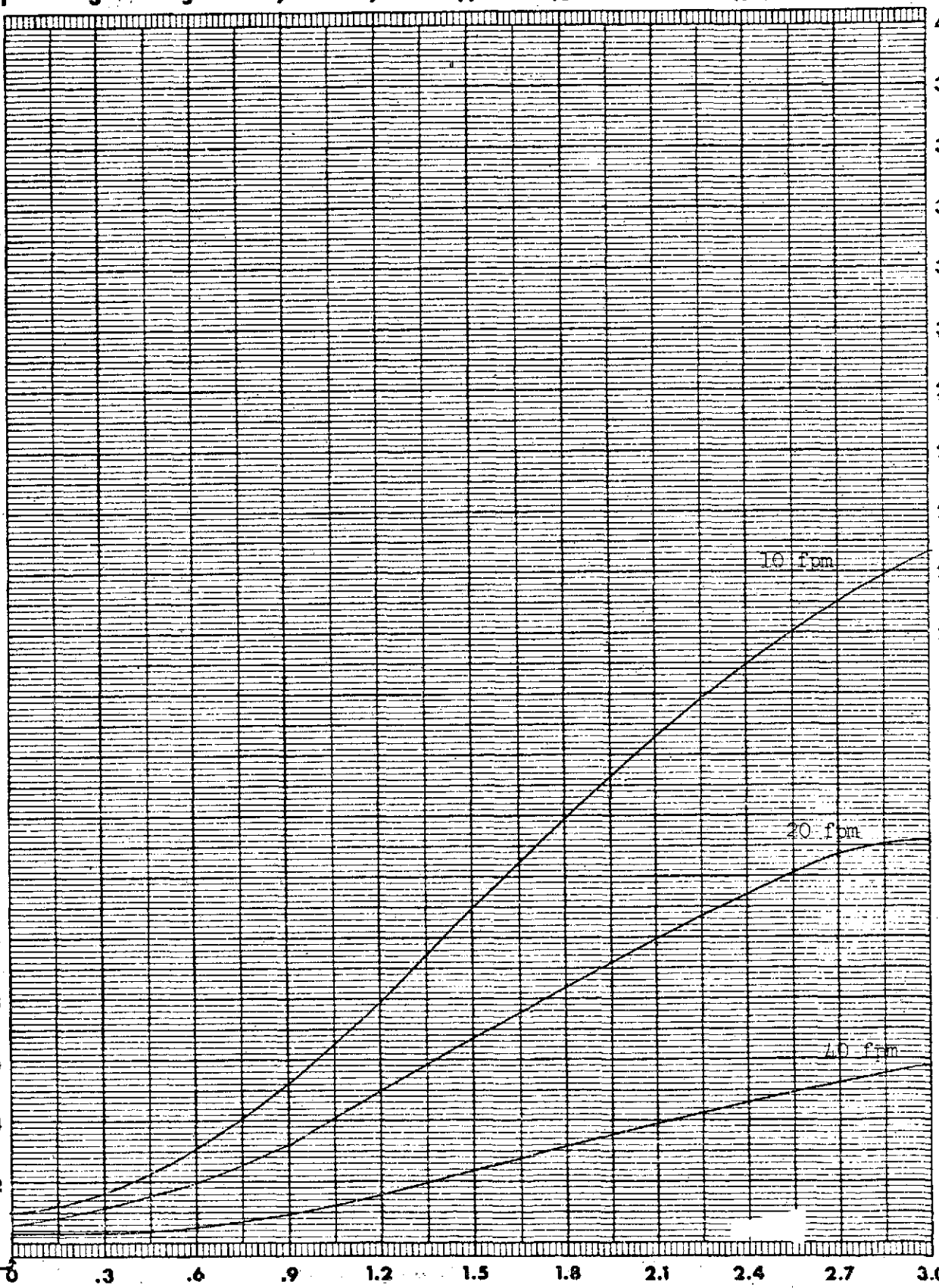

Technicolor

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

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DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM duPont SR-112 EMULSION # _____ MFG _____ EXPIRATION DATE _____

EXPOSURE DATA (792-150, 2489)	PROCESSING DATA	DENSITOMETRY
SENSITOMETER I-B PS6809	PROCESSOR Fultron # 1	INSTRUMENT MacBeth
ILLUMINANT 3000 °K	CHEMISTRY SCO 10R	TYPE TD217DR
TIME ½ SEC.	SPEED _____ TANKS 10,20,40 FPM	APERTURE SIZE 4 MM
FILTER none	TEMP °F 80 TIME _____	FILTER Visual
		SPEED ( ) _____
		D-MAX _____
		GAMMA _____
		BASE + FOG _____

CHEMICAL ANALYSIS

SP GR _____

pH _____

TA _____

TRP _____

KB$_r$ _____

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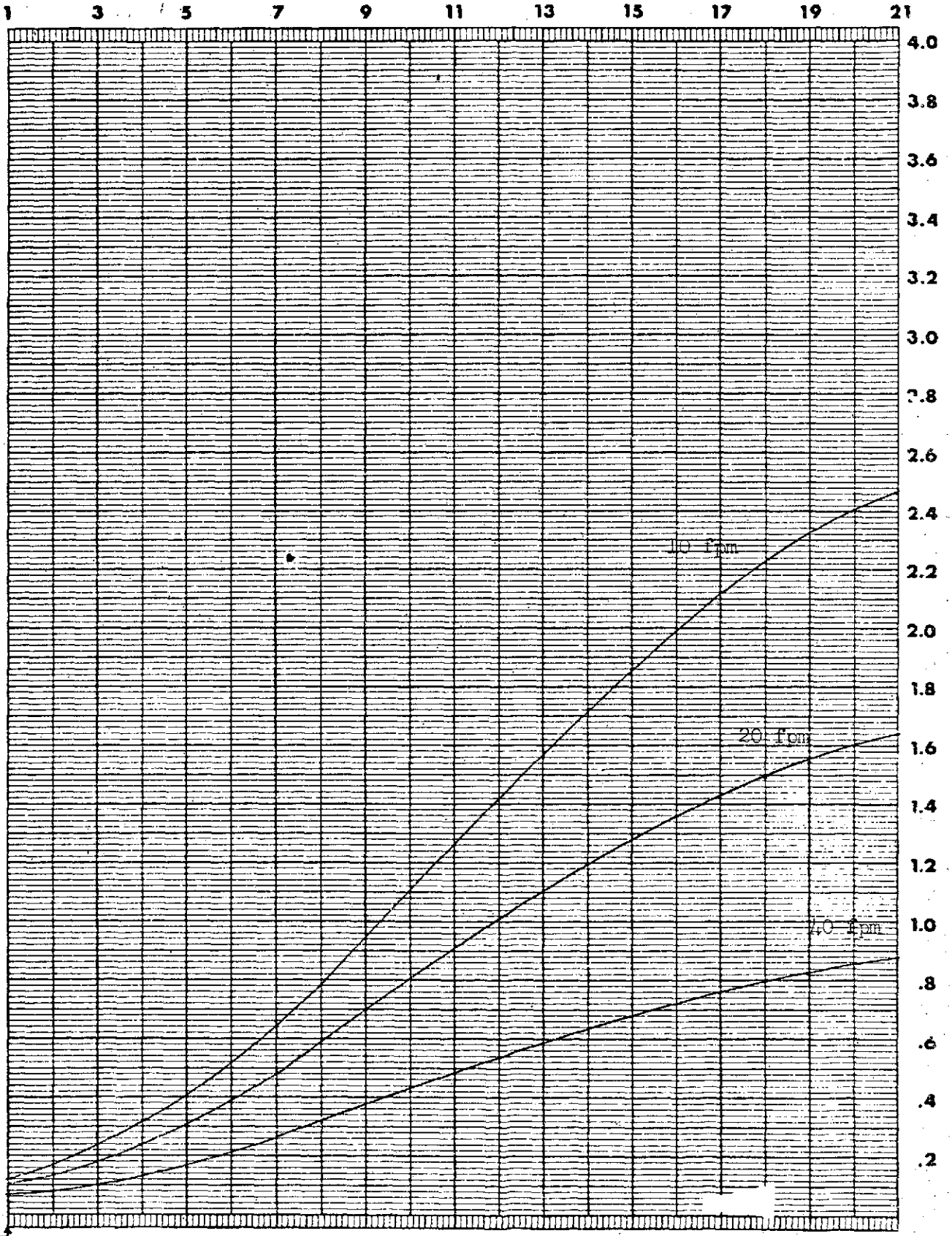

Technicolor

ABSOLUTE LOG E AT R.L.E. 0 -10

T71-21 NASA — MSC

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM SR 112 EMULSION # 150-3 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA 2489 (792-150)	PROCESSING DATA	DENSITOMETRY
SENSITOMETER I-3 PS6809	PROCESSOR Fultron # 1	INSTRUMENT MacBeth / SPEED ( )
ILLUMINANT 3000 °K	CHEMISTRY MX-641	TYPE TD217DR / D-MAX
TIME 1/2 SEC.	SPEED ____ TANKS 10,20,40 PM	APERTURE SIZE 4 MM / GAMMA
FILTER none	TEMP °F 68 TIME ____	FILTER Visual / BASE + FOG

CHEMICAL ANALYSIS

SP GR

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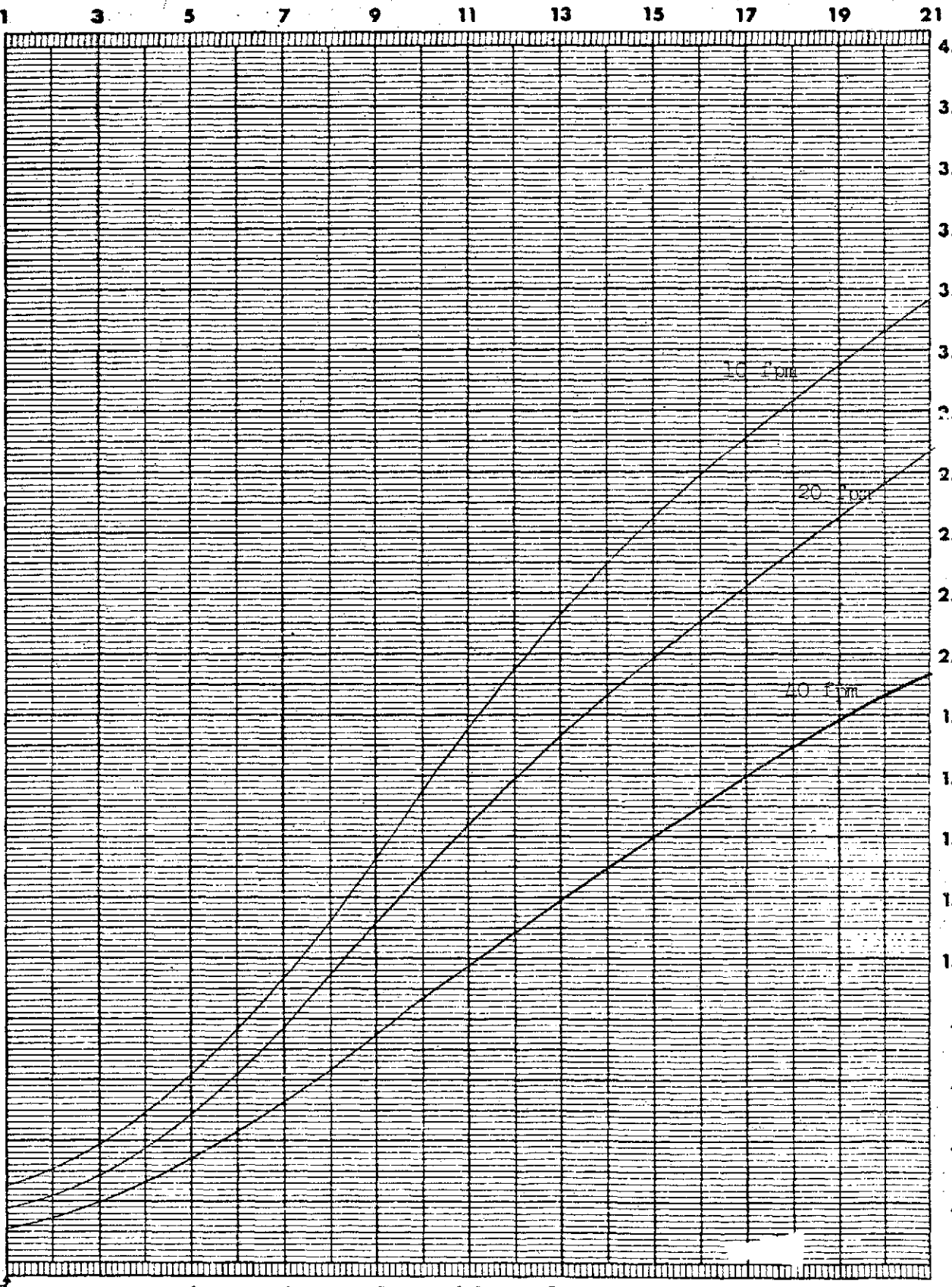

Technicolor

ABSOLUTE LOG E AT R.L.E. 0 / -10

T71-21 NASA — MSC

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM SR 112 EMULSION # 150-3 MFG _____ EXPIRATION DATE _____

792-150 EXPOSURE DATA 2489	PROCESSING DATA	DENSITOMETRY
SENSITOMETER I-B PS6809	PROCESSOR Fultron # 1	INSTRUMENT Mac Beth / SPEED ( )
ILLUMINANT 3000 °K	CHEMISTRY MX-641	TYPE TD217DR / D-MAX
TIME 1/2 SEC.	SPEED TANKS 10,20,40 FPM	APERTURE SIZE 4 MM / GAMMA
FILTER none	TEMP °F 80 TIME	FILTER Visual / BASE + FOG

CHEMICAL ANALYSIS

SP GR

pH

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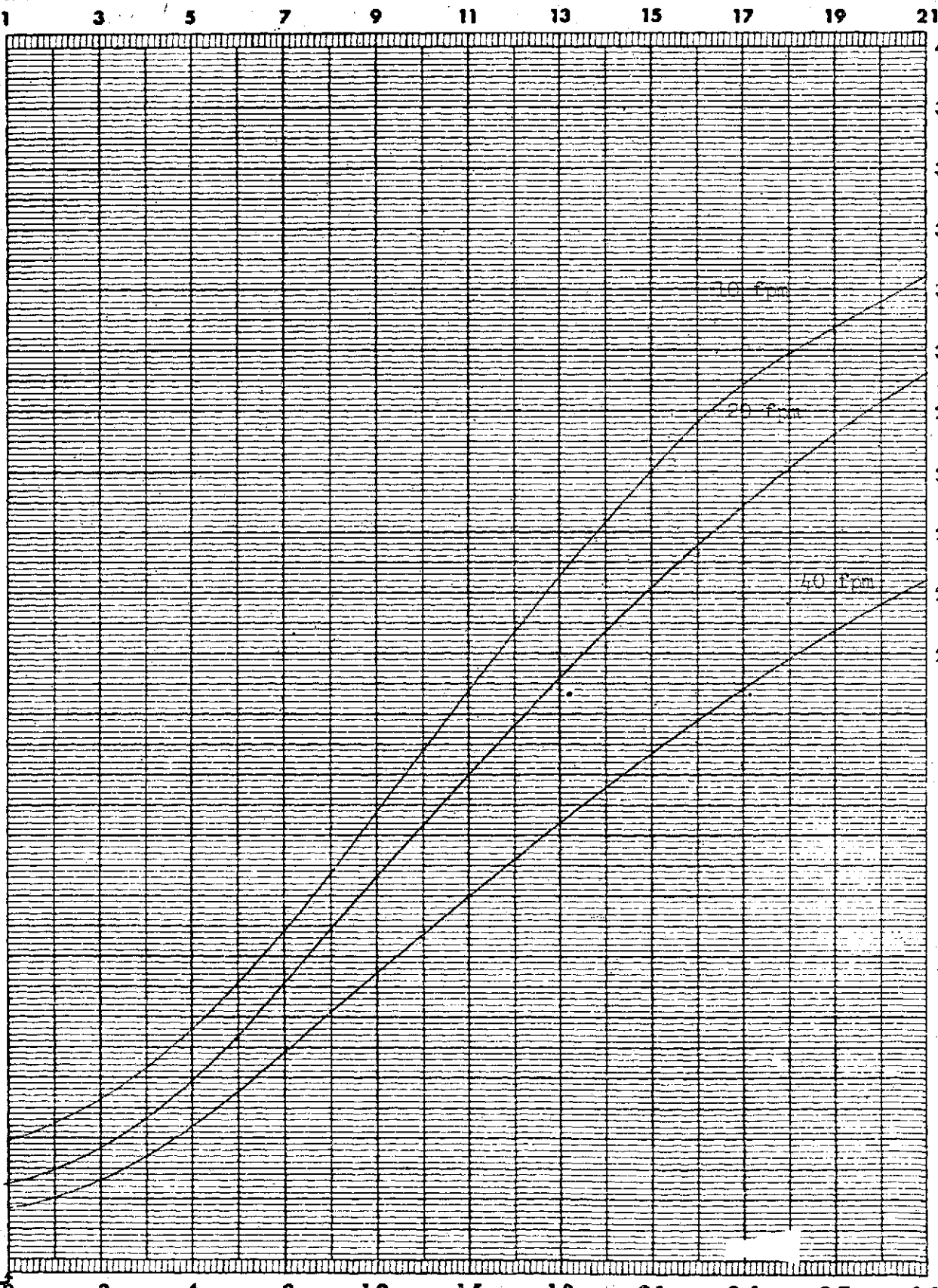

Technicolor

ABSOLUTE LOG E AT R.L.E. 0

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T71-21 NASA — MSC

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # 178-1 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
792-150 2489		
SENSITOMETER I-B PS6809	PROCESSOR Fultron # 1	INSTRUMENT MacBeth
ILLUMINANT 3000 °K	CHEMISTRY MX-641	TYPE TD217DR
TIME 1 SEC.	SPEED ____ TANKS 10,20,40 FPM	APERTURE SIZE 4 MM
FILTER none	TEMP °F 68 TIME ____	FILTER Visual

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

CHEMICAL ANALYSIS

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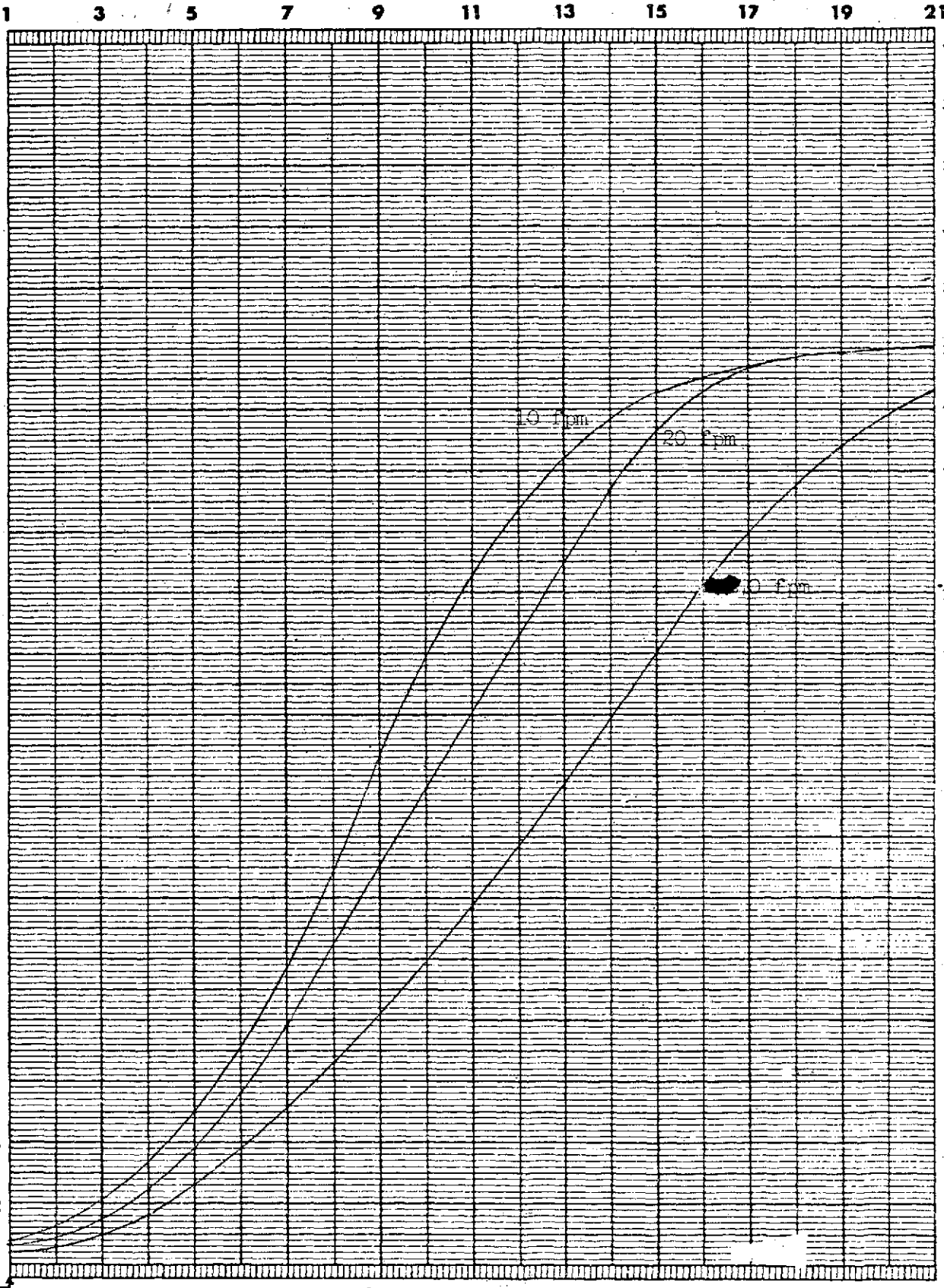

Technicolor

ABSOLUTE LOG E AT R.L.E. 0 -10

T71-21 NASA — MSC

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # 178-1 MFG _____ EXPIRATION DATE _____

792-150 EXPOSURE DATA 2489	PROCESSING DATA	DENSITOMETRY
SENSITOMETER I-B PS6809	PROCESSOR Fultron # 1	INSTRUMENT MacBeth / SPEED ( )
ILLUMINANT 3000 °K	CHEMISTRY MX-641	TYPE TD217DR / D-MAX
TIME 1 SEC.	SPEED ___ TANKS 10,20,40 FPM	APERTURE SIZE 4 MM / GAMMA
FILTER none	TEMP °F 80 TIME ___	FILTER Visual / BASE + FOG

CHEMICAL ANALYSIS

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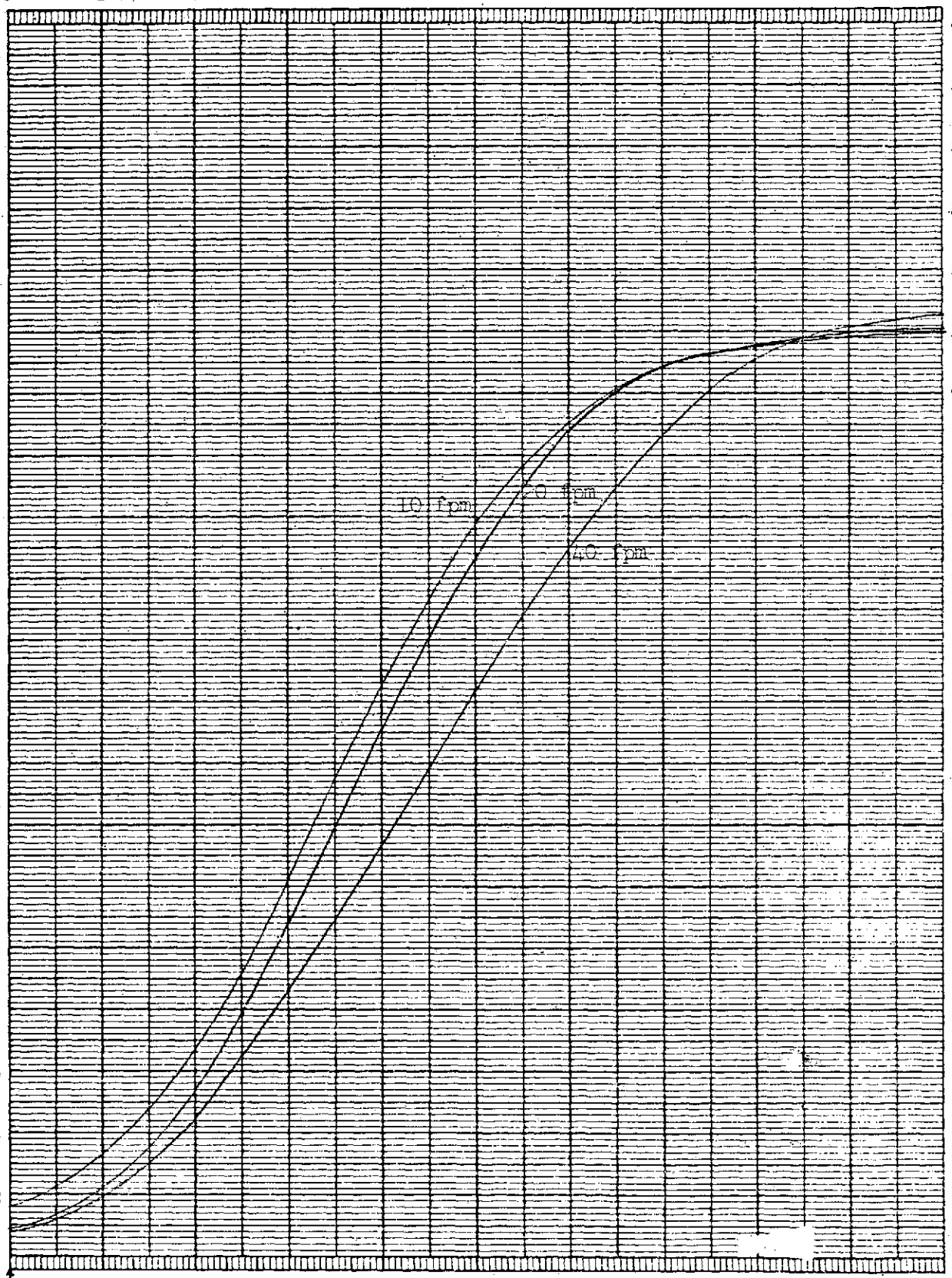

Technicolor

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

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NASA — MSC

T71-21

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # 175-14 MFG _____ EXPIRATION DATE _____

792-150 EXPOSURE DATA 2489	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B PS6809	PROCESSOR Fultron # 1	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT 3000 °K	CHEMISTRY MX-641	TYPE TD217DR	D-MAX
TIME 1 SEC.	SPEED TANKS 10,20,40 FPM	APERTURE SIZE 4 MM	GAMMA
FILTER none	TEMP °F 68 TIME	FILTER Visual	BASE + FOG

CHEMICAL ANALYSIS

SP GR

pH

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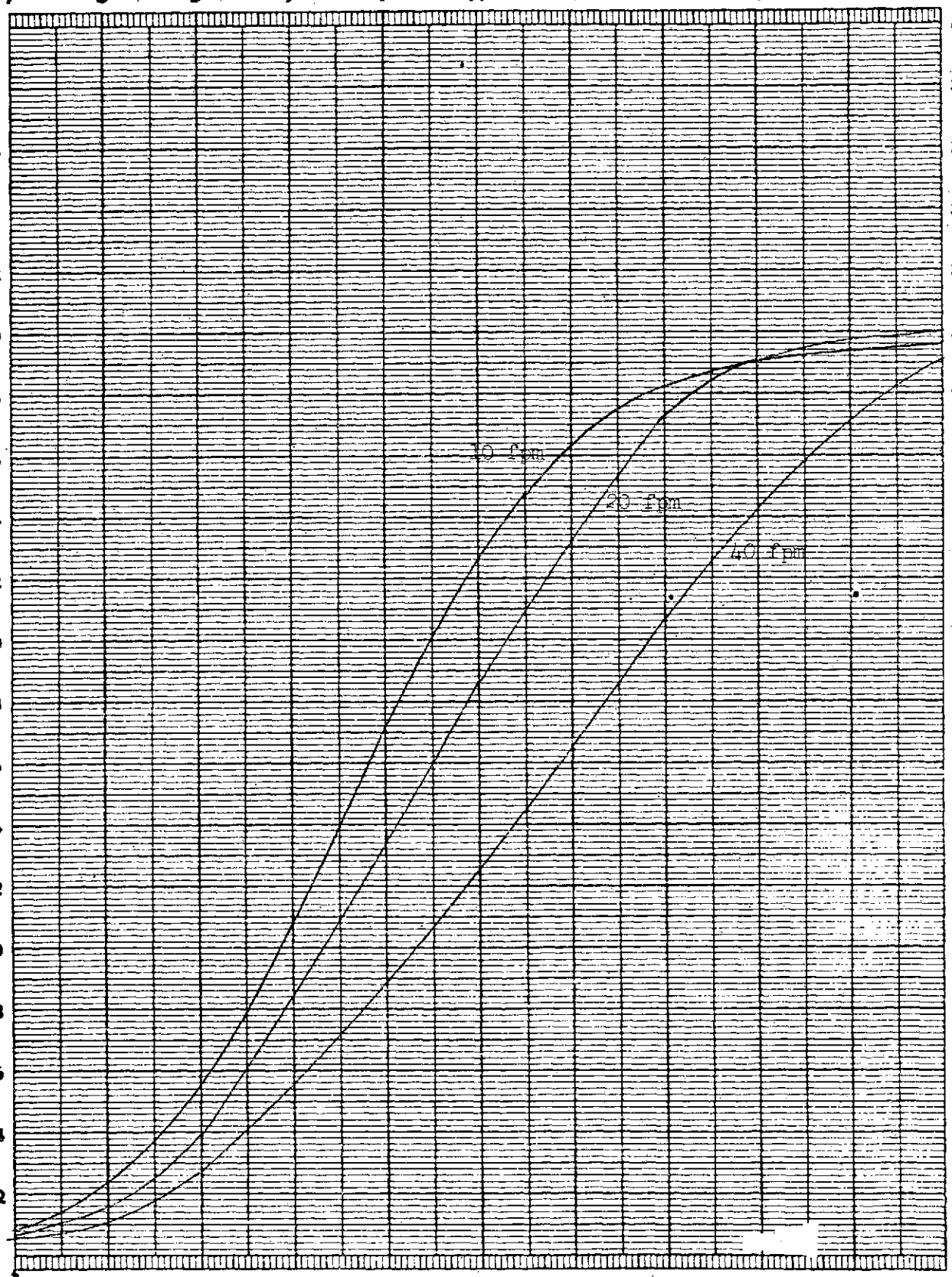

Technicolor

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

-10

NASA — MSC

T71-21

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # 175-25 MFG _____ EXPIRATION DATE _____

792-15 EXPOSURE DATA 2489	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER I-B PS6809	PROCESSOR Fultron # 1	INSTRUMENT MacBeth	SPEED ( ) _____
ILLUMINANT 3000°K	CHEMISTRY MX-641	TYPE TD217DR	D-MAX _____
TIME 1 SEC.	SPEED _____ TANKS 10,20,40 FPM	APERTURE SIZE 4 MM	GAMMA _____
FILTER none	TEMP °F 80 TIME _____	FILTER Visual	BASE + FOG _____

CHEMICAL ANALYSIS

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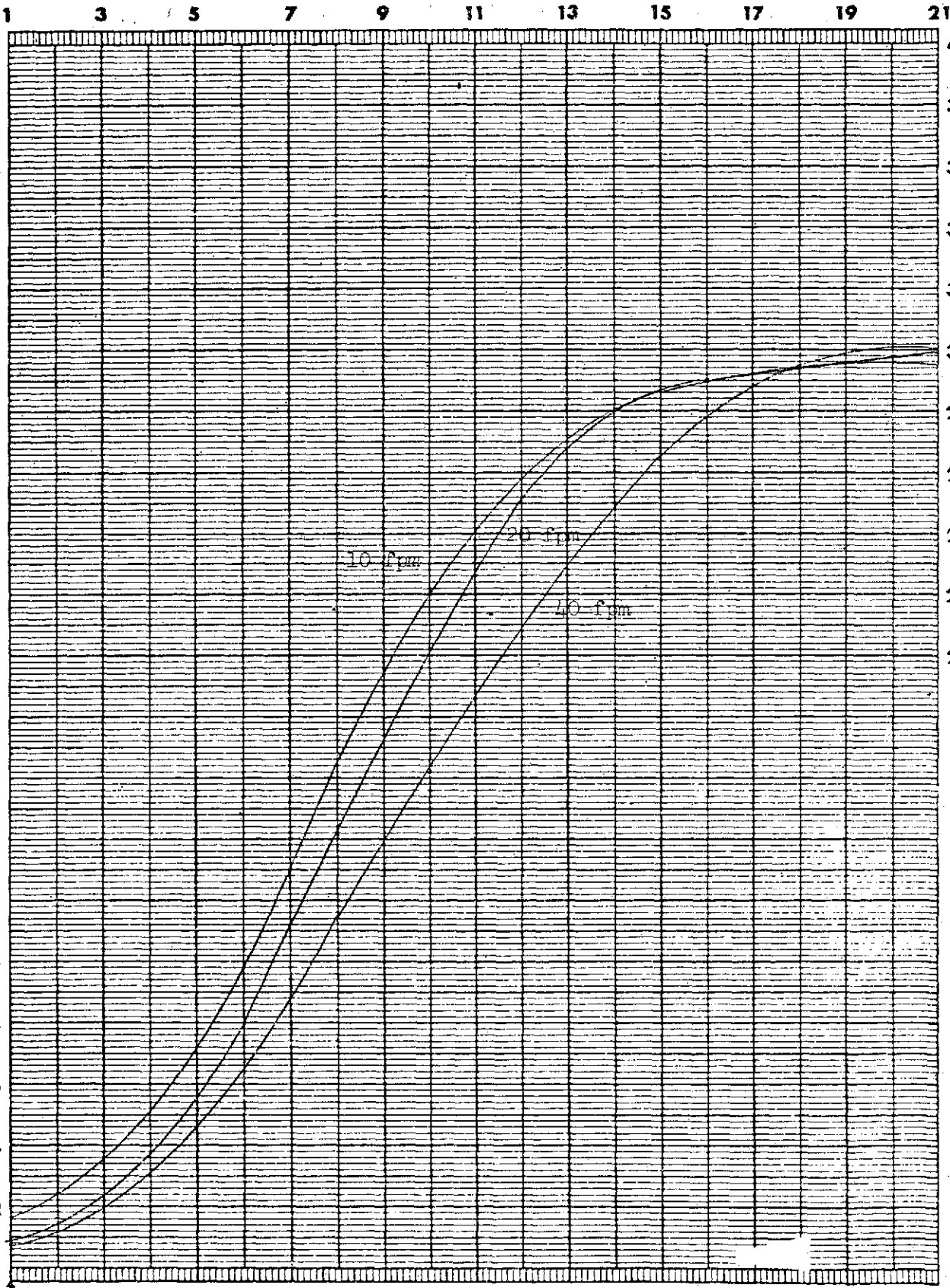

Technicolor

ABSOLUTE LOG E AT R.L.E. 0 -10

T71-21 NASA — MSC

DATE 2 March 72 CONTROL # 9 5" TASK HT-36 PREPARED BY E. Weizer

FILM EE-2628 EMULSION # _____ MFG E.K. Co. EXPIRATION DATE _____

792 EXPOSURE DATA 2489	PROCESSING DATA	DENSITOMETRY
SENSITOMETER 1-B	PROCESSOR Fultron	INSTRUMENT Macbeth / SPEED ( )
ILLUMINANT 3000 °K	CHEMISTRY MX-641	TYPE TD 403 / D-MAX
TIME 1/2 SEC.	SPEED ____ TANKS ____ FPM	APERTURE SIZE 4 MM / GAMMA
FILTER None	TEMP °F 68 TIME ____	FILTER Visual / BASE + FOG

CHEMICAL ANALYSIS

SP GR

pH

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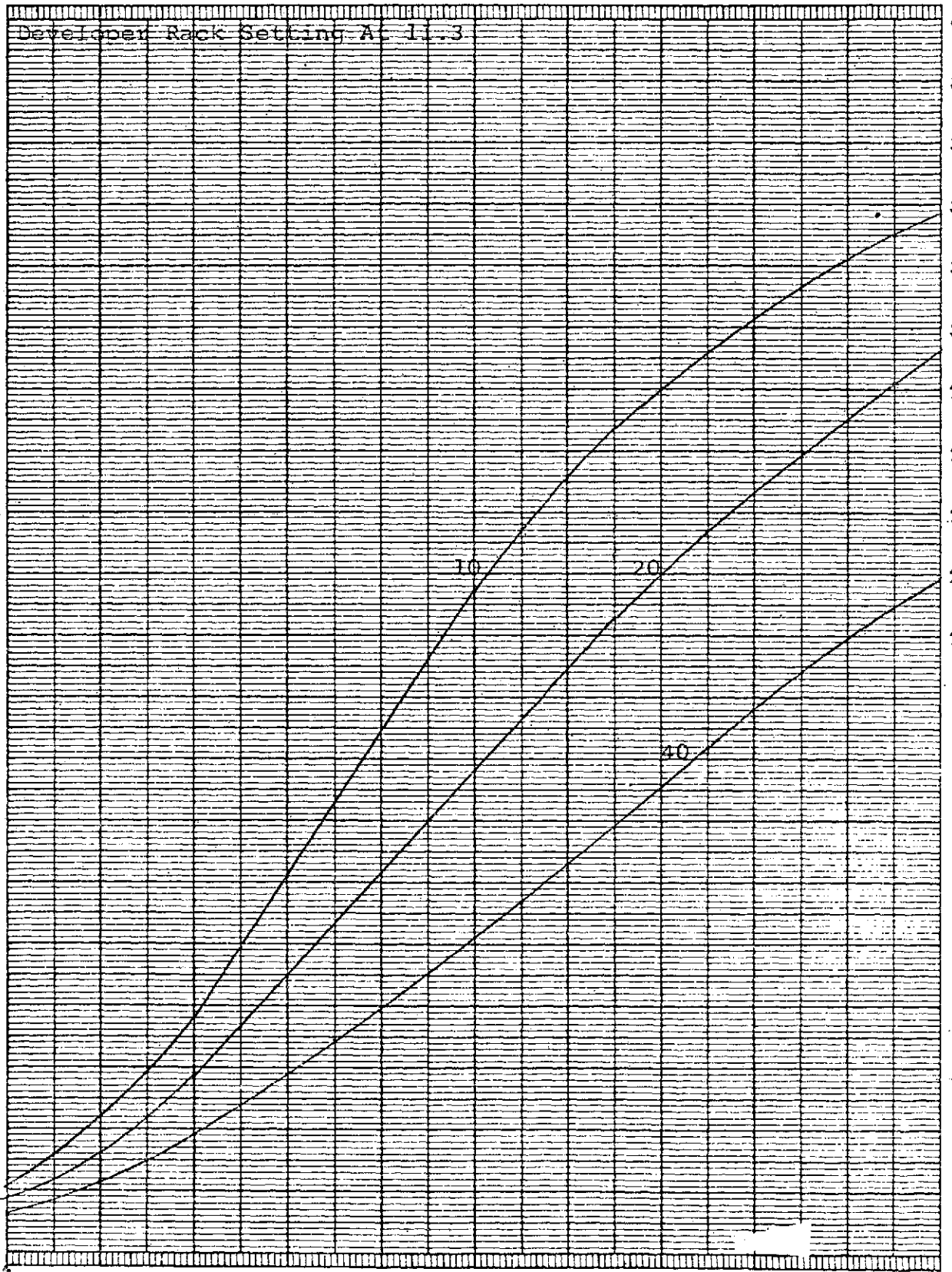

Technicolor

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

9 54 -10

NASA — MSC

T71-21

DATE 2 March 72 CONTROL # 9 5" TASK Ht-36 PREPARED BY E. Weizer

FILM EE-2628 EMULSION # _____ MFG E.K. Co. EXPIRATION DATE _____

EXPOSURE DATA 2489	PROCESSING DATA	DENSITOMETRY
792		
SENSITOMETER 1-B	PROCESSOR Fultron	INSTRUMENT Macbeth / SPEED ( )
ILLUMINANT 3000 °K	CHEMISTRY Mx-641	TYPE TD 403 / D-MAX
TIME 1/2 SEC.	SPEED ____ TANKS ____ FPM	APERTURE SIZE 4 MM / GAMMA
FILTER None	TEMP °F 80 TIME ____	FILTER Visual / BASE + FOG

CHEMICAL ANALYSIS

SP GR _____

pH _____

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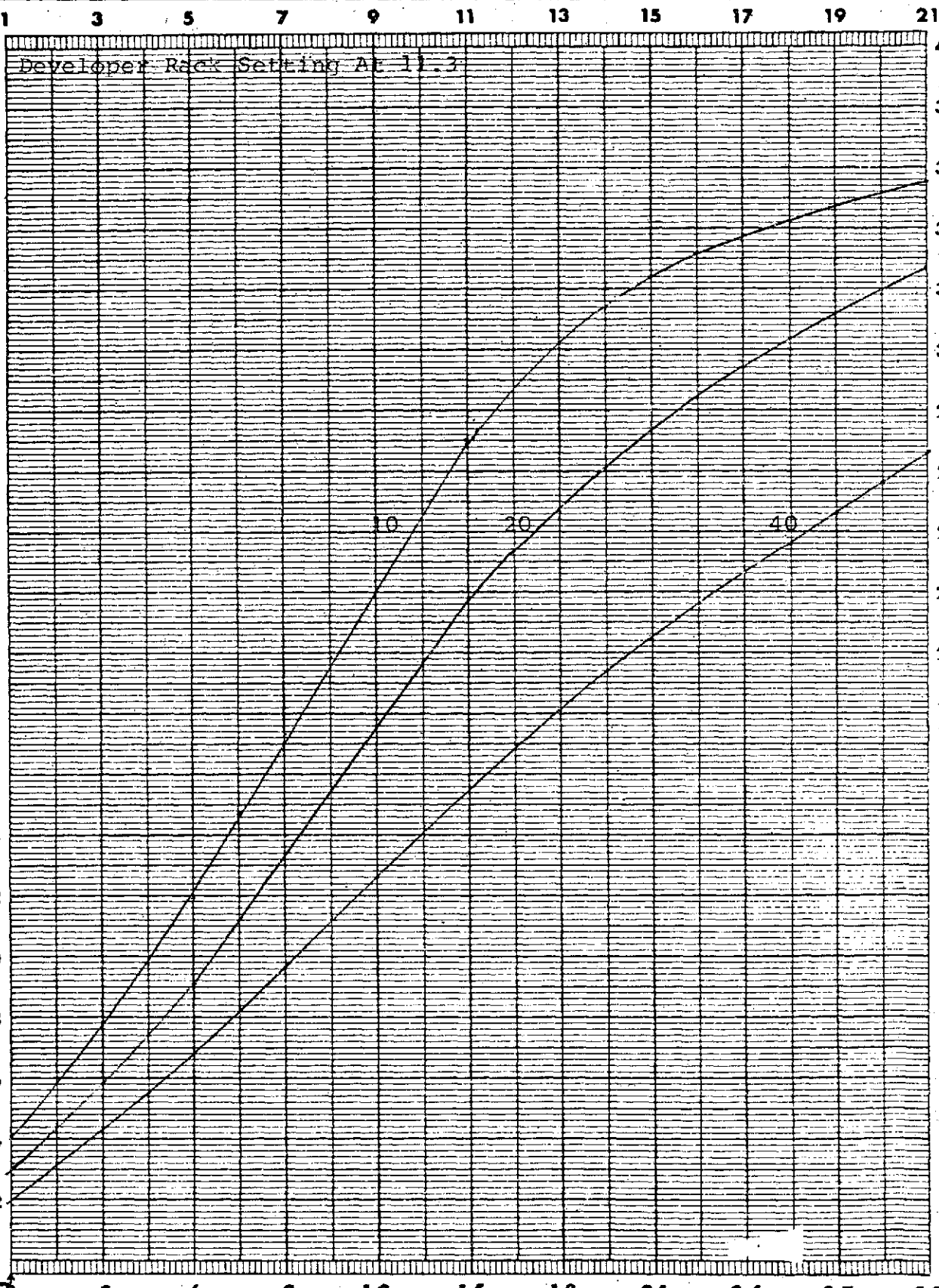

Technicolor

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

9.54 -10

T71-21 NASA — MSC

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2422 EMULSION # _____ MFG _____ EXPIRATION DATE _____

EXPOSURE DATA 2489	PROCESSING DATA	DENSITOMETRY
792-150		
SENSITOMETER I-B PS6809	PROCESSOR Fultron # 1	INSTRUMENT MacBeth / SPEED ( )
ILLUMINANT 3000 °K	CHEMISTRY MX-641	TYPE TD217DR / D-MAX
TIME 4 SEC.	SPEED TANKS 10,20,40 FPM	APERTURE SIZE 4 MM / GAMMA
FILTER none	TEMP °F 80 TIME	FILTER Visual / BASE + FOG

CHEMICAL ANALYSIS

SP GR

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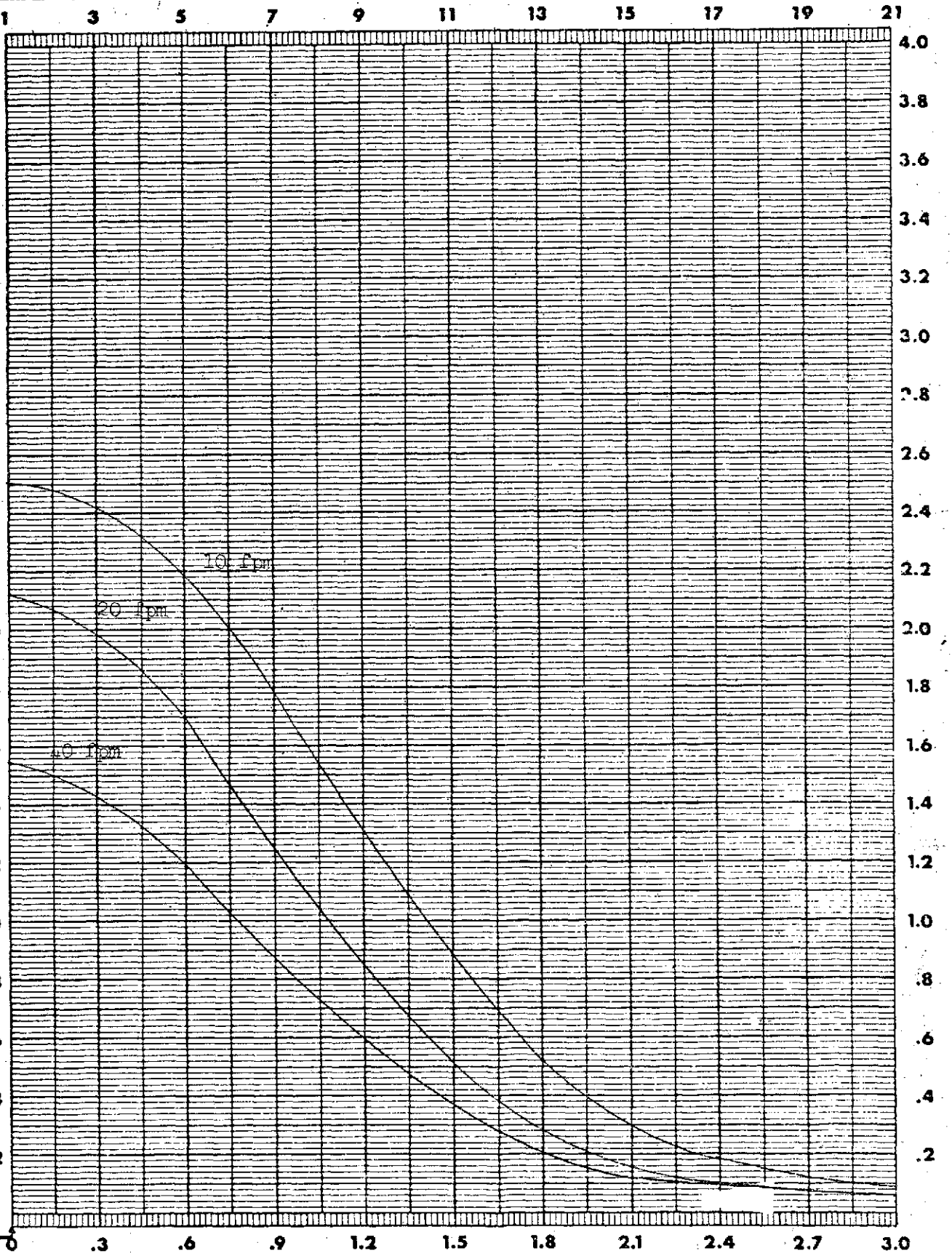

Technicolor

ABSOLUTE LOG E AT R.L.E. 0

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171-21 NASA — MSC

APPENDIX B

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM SR 112 EMULSION # _____ MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER Niagara	PROCESSOR Fultron # 1	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT ____ °K	CHEMISTRY SCO 10R	TYPE TD217DR	D-MAX
TIME ____ SEC.	SPEED ____ TANKS 10, 20, 40 FPM	APERTURE SIZE 4 MM	GAMMA
FILTER	TEMP °F 68 TIME	FILTER Visual	BASE + FOG

CHEMICAL ANALYSIS

SP GR

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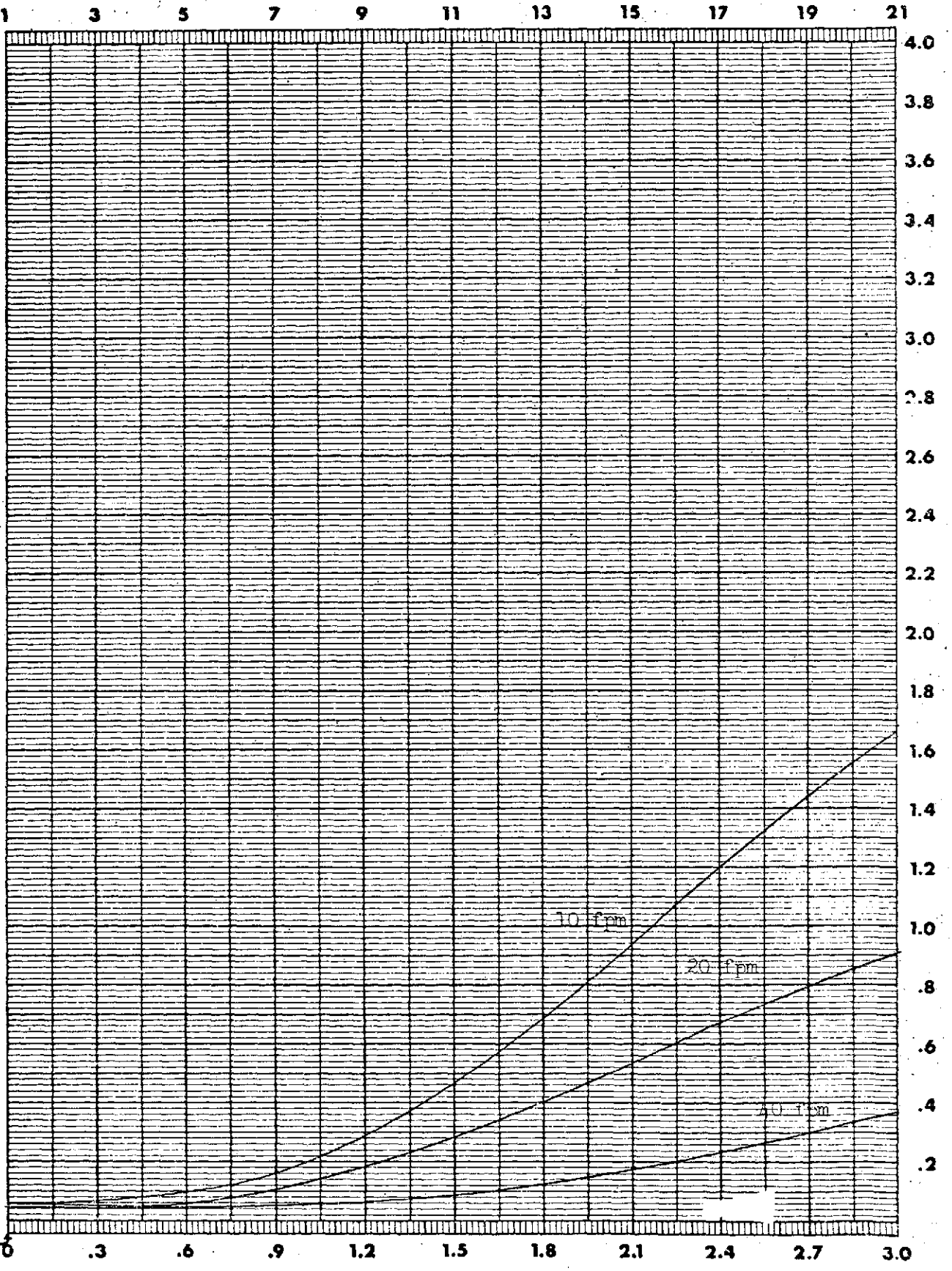

Technicolor

ABSOLUTE LOG E AT R.L.E. = 0 −10

T71-21 NASA — MSC

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM SR 112 EMULSION # _____ MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY
SENSITOMETER Niagara	PROCESSOR Fultron # 1	INSTRUMENT MacBeth / SPEED ( )
ILLUMINANT _____ °K	CHEMISTRY SCO 10R	TYPE TD217 DR / D-MAX
TIME _____ SEC.	SPEED _____ TANKS 10, 20, 40 FPM	APERTURE SIZE 4 MM / GAMMA
FILTER _____	TEMP °F 80 TIME _____	FILTER Visual / BASE + FOG

CHEMICAL ANALYSIS

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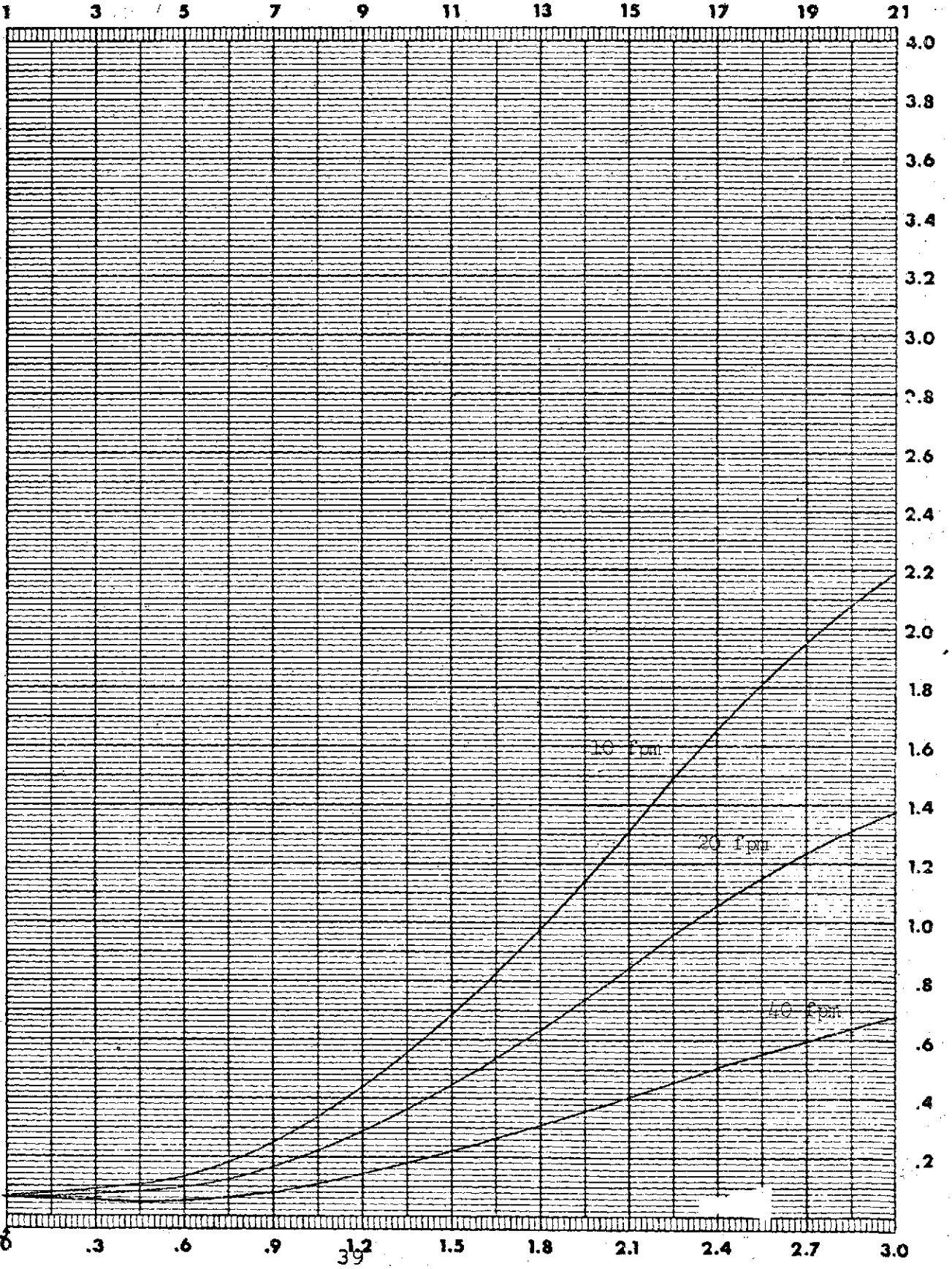

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ABSOLUTE LOG E AT R.L.E. = 0

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DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM SR 112 EMULSION # _____ MFG _____ EXPIRATION DATE _____

3400 EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER Niagara	PROCESSOR Fultron # 1	INSTRUMENT MacBeth	SPEED ( ) _____
ILLUMINANT _____ °K	CHEMISTRY MX-641	TYPE TD217 DR	D-MAX _____
TIME _____ SEC.	SPEED _____ TANKS 10,20,40 FPM	APERTURE SIZE 4 MM	GAMMA _____
FILTER _____	TEMP °F 68 TIME _____	FILTER Visual	BASE + FOG _____

CHEMICAL ANALYSIS

SP GR

pH

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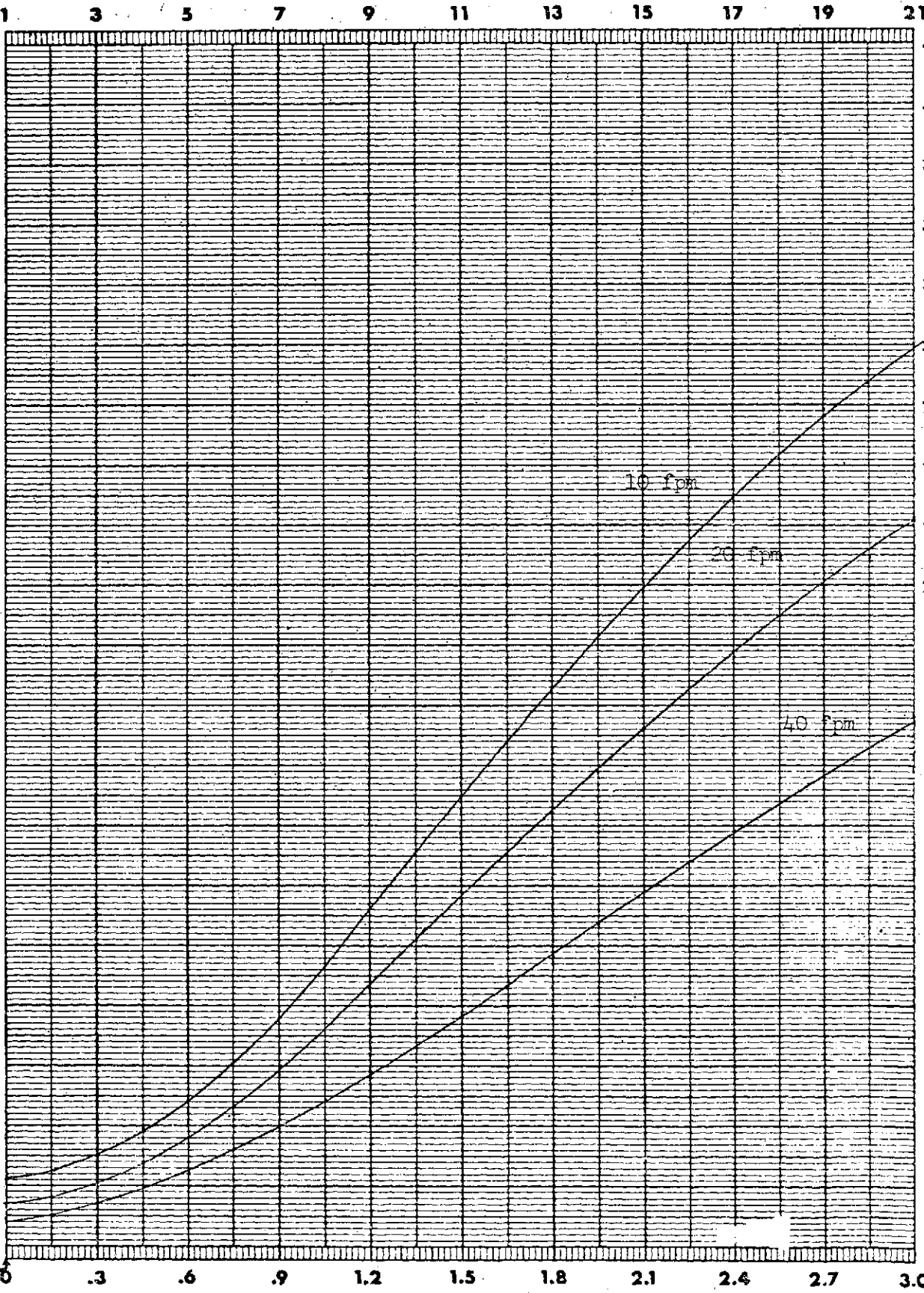

Technicolor

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

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T71-21 NASA — MSC

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM SR 112 EMULSION # _____ MFG _____ EXPIRATION DATE _____

3400 EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER Niagara	PROCESSOR Fultron # 1	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT ____ °K	CHEMISTRY MX-641	TYPE TD217DR	D-MAX
TIME ____ SEC.	SPEED ____ TANKS 10,20,40 FPM	APERTURE SIZE 4 MM	GAMMA
FILTER	TEMP °F 80 TIME	FILTER Visual	BASE + FOG

CHEMICAL ANALYSIS

SP GR

pH

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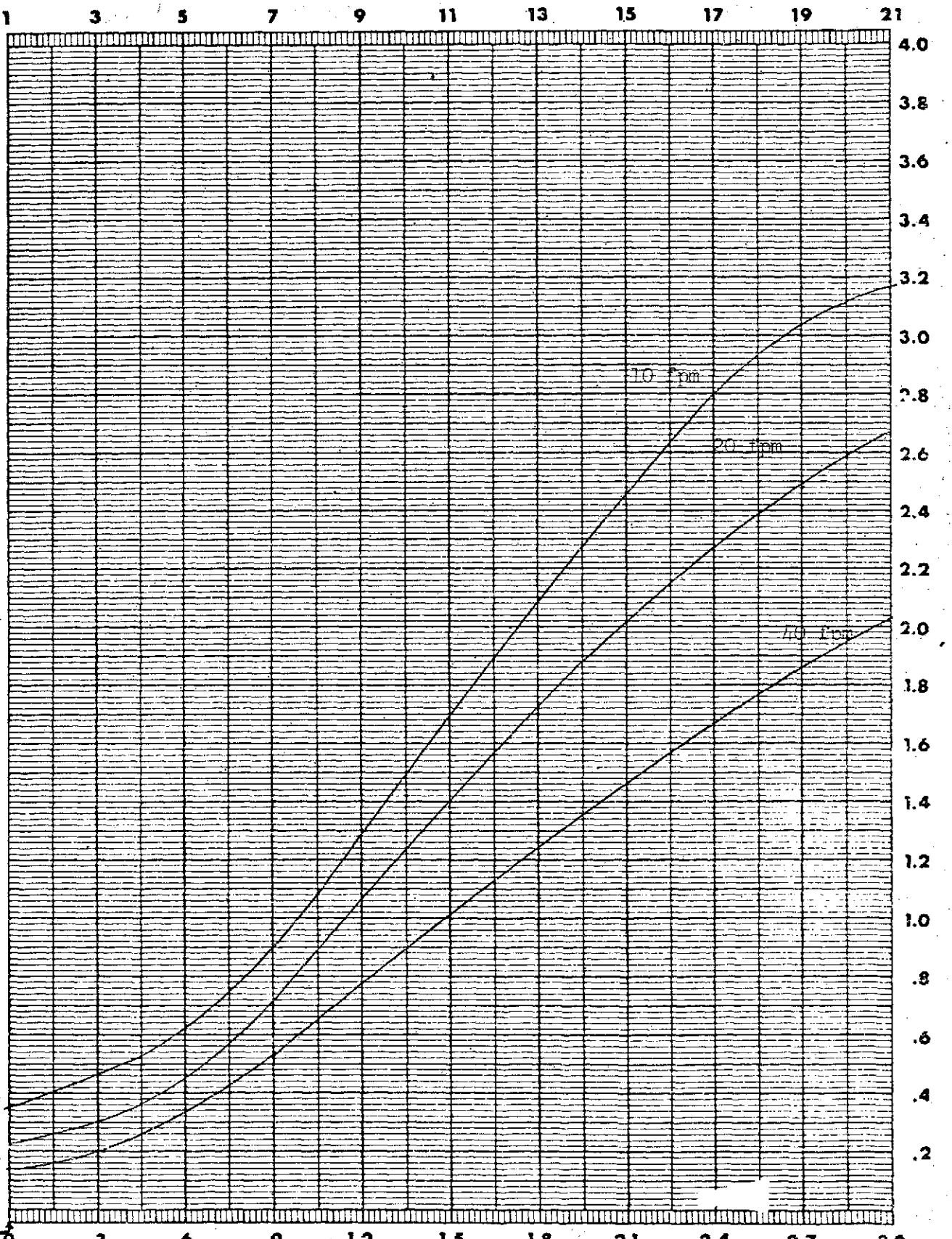

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ABSOLUTE LOG E AT R.L.E. = 0

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T71-21 NASA — MSC

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # _____ MFG _____ EXPIRATION DATE _____

3400 EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER Niagara	PROCESSOR Fultron # 1	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT ____ °K	CHEMISTRY MX-641	TYPE TD217DR	D-MAX
TIME ____ SEC.	SPEED ____ TANKS 10,20,40 FPM	APERTURE SIZE 4 MM	GAMMA
FILTER ____	TEMP °F 68 TIME ____	FILTER Visual	BASE + FOG

CHEMICAL ANALYSIS

SP GR

pH

TA

TRP

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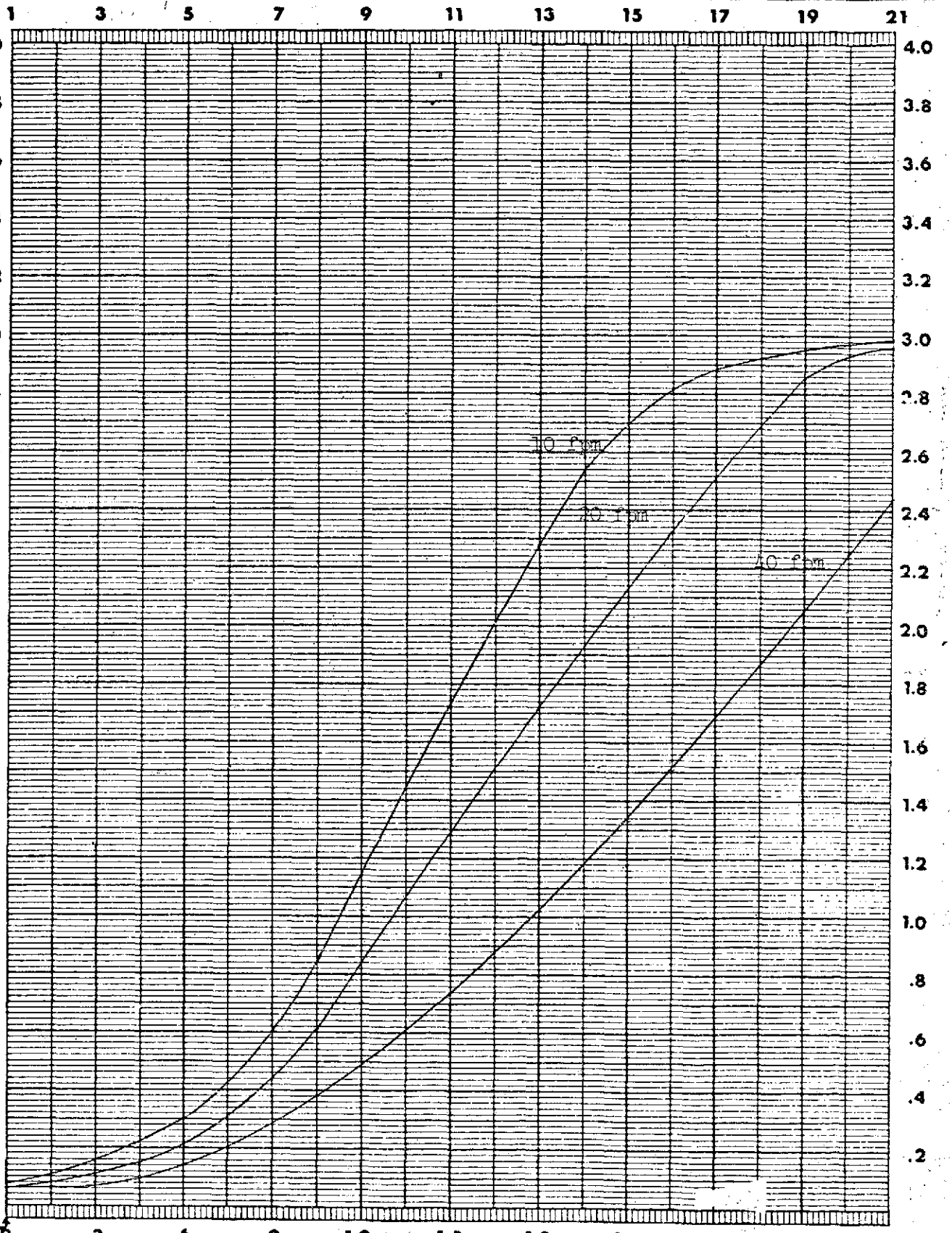

Technicolor

ABSOLUTE LOG E AT R.L.E. 0 −10

T71-21 NASA — MSC

DATE ~~Feb 1972~~ CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2430 EMULSION # _____ MFG _____ EXPIRATION DATE _____

3400 EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER Niagara	PROCESSOR Fultron # 1	INSTRUMENT MacBeth	SPEED ( )
ILLUMINANT ____ °K	CHEMISTRY MX-641	TYPE TD217DR	D-MAX
TIME ____ SEC.	SPEED ____ TANKS 10,20,40 FPM	APERTURE SIZE 4 MM	GAMMA
FILTER ____	TEMP °F 80 TIME ____	FILTER Visual	BASE + FOG

CHEMICAL ANALYSIS

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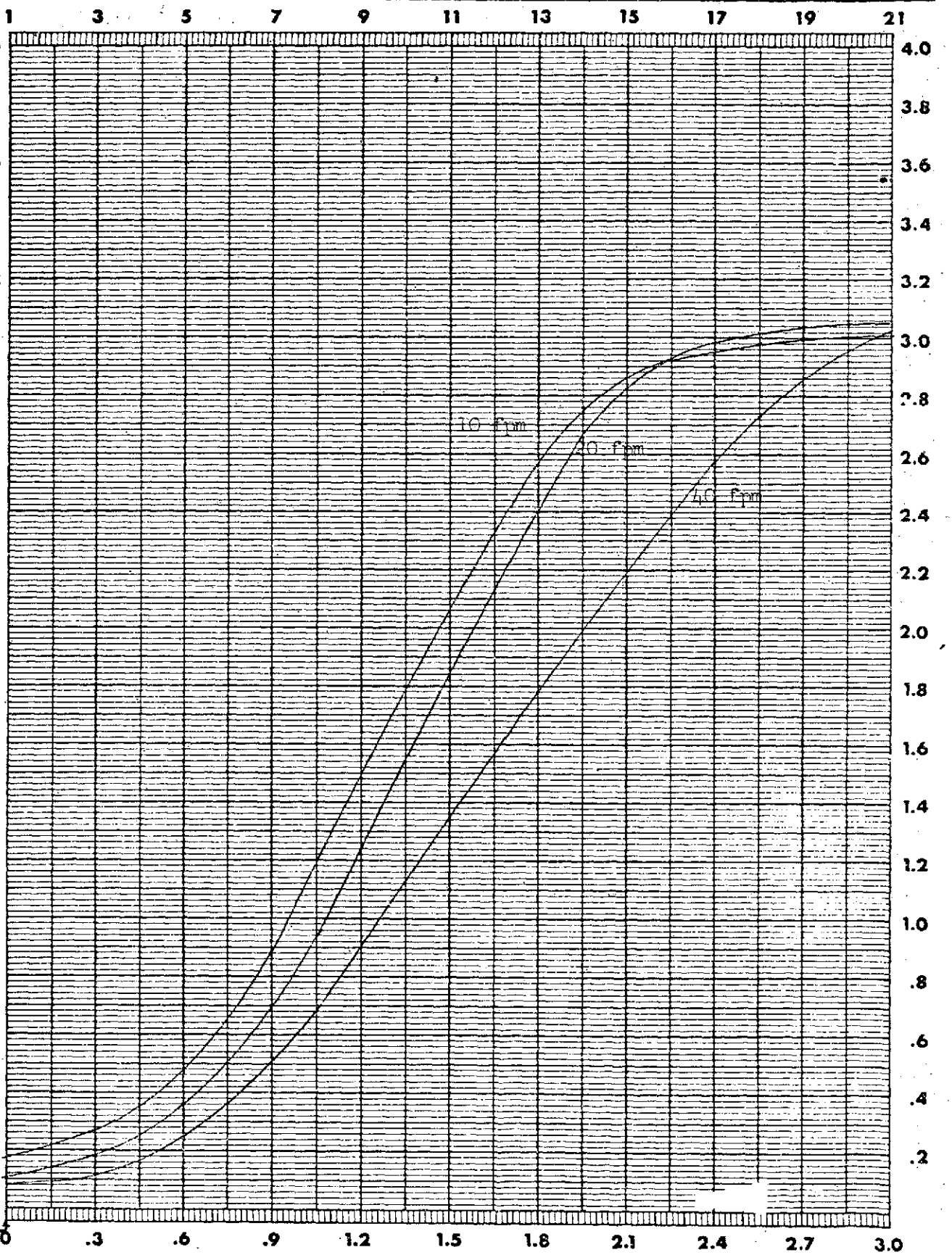

Technicolor

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

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T71-21 NASA — MSC

DATE Feb 1972 CONTROL # _____ TASK _____ PREPARED BY _____

FILM 2422 EMULSION # 11-19 MFG _____ EXPIRATION DATE _____

EXPOSURE DATA	PROCESSING DATA	DENSITOMETRY	
SENSITOMETER Niagara	PROCESSOR Fultron #1	INSTRUMENT MacBeth	SPEED ( ) _____
ILLUMINANT _____ °K	CHEMISTRY MX-641	TYPE TD217DR	D-MAX _____
TIME _____ SEC.	SPEED _____ TANKS 10,20,40 FPM	APERTURE SIZE 4 MM	GAMMA _____
FILTER _____	TEMP °F 80 TIME _____	FILTER Visual	BASE + FOG _____

CHEMICAL ANALYSIS

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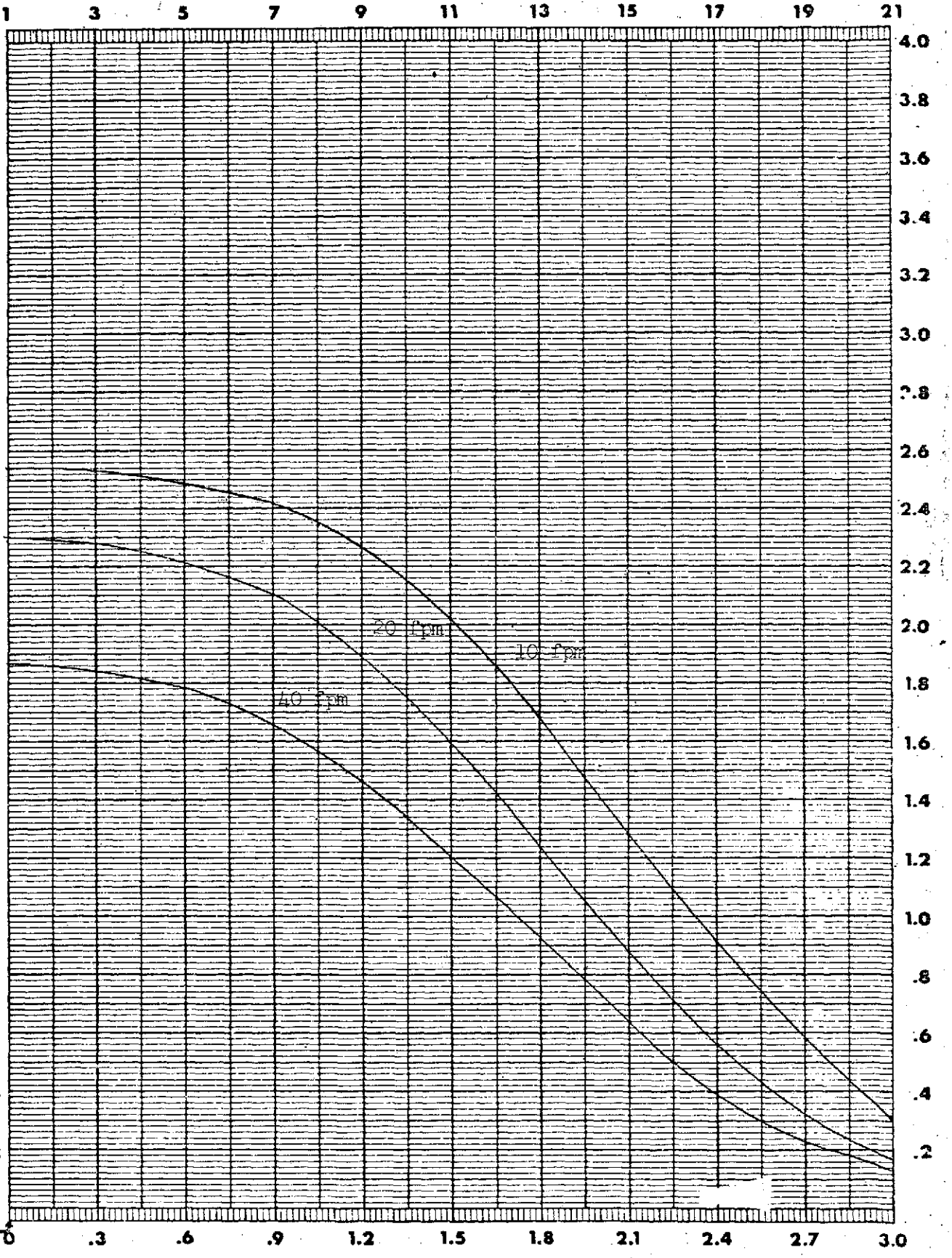

Technicolor

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

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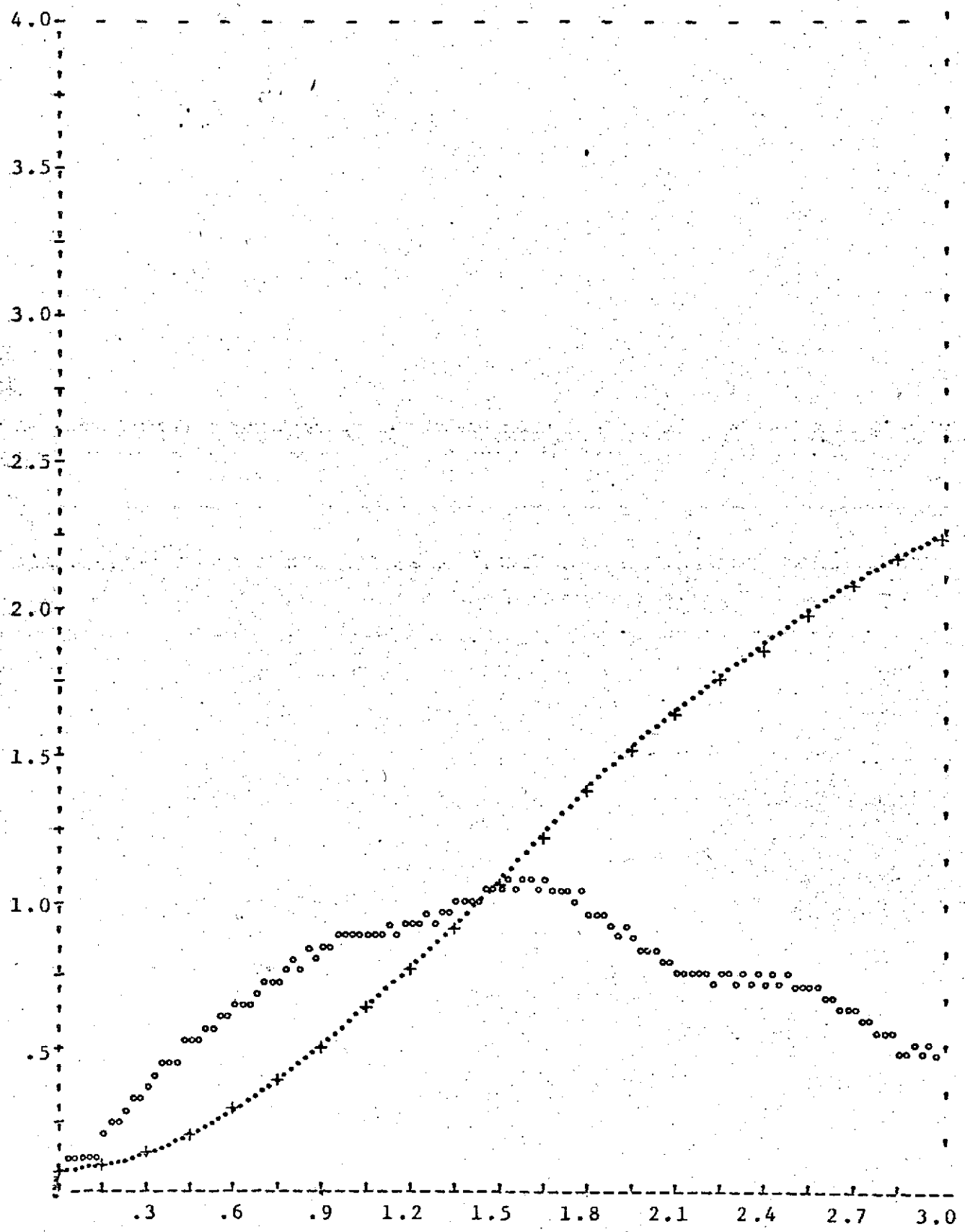
T71-21 NASA — MSC

APPENDIX C

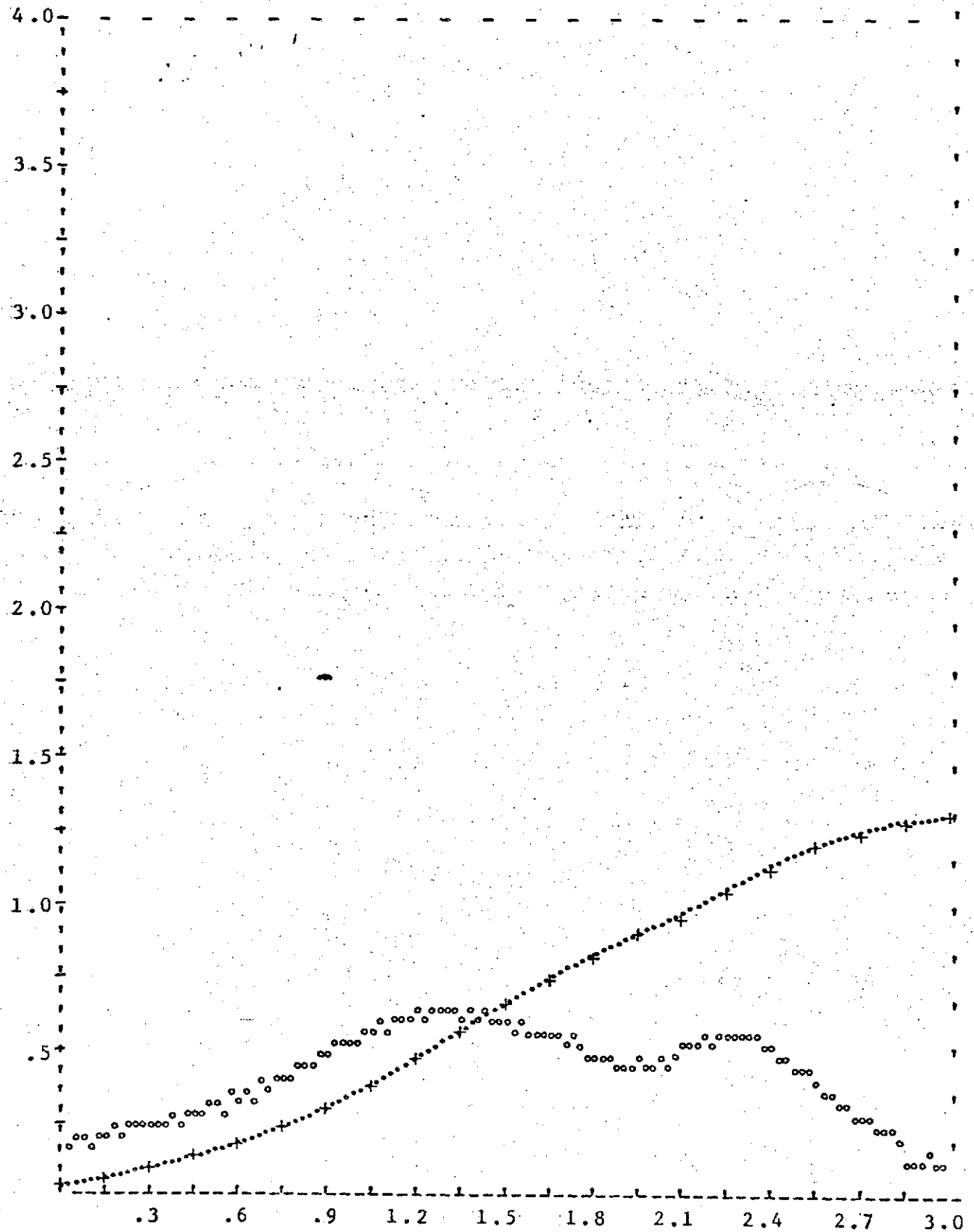
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB SCOTOR 10 fpm 68°F



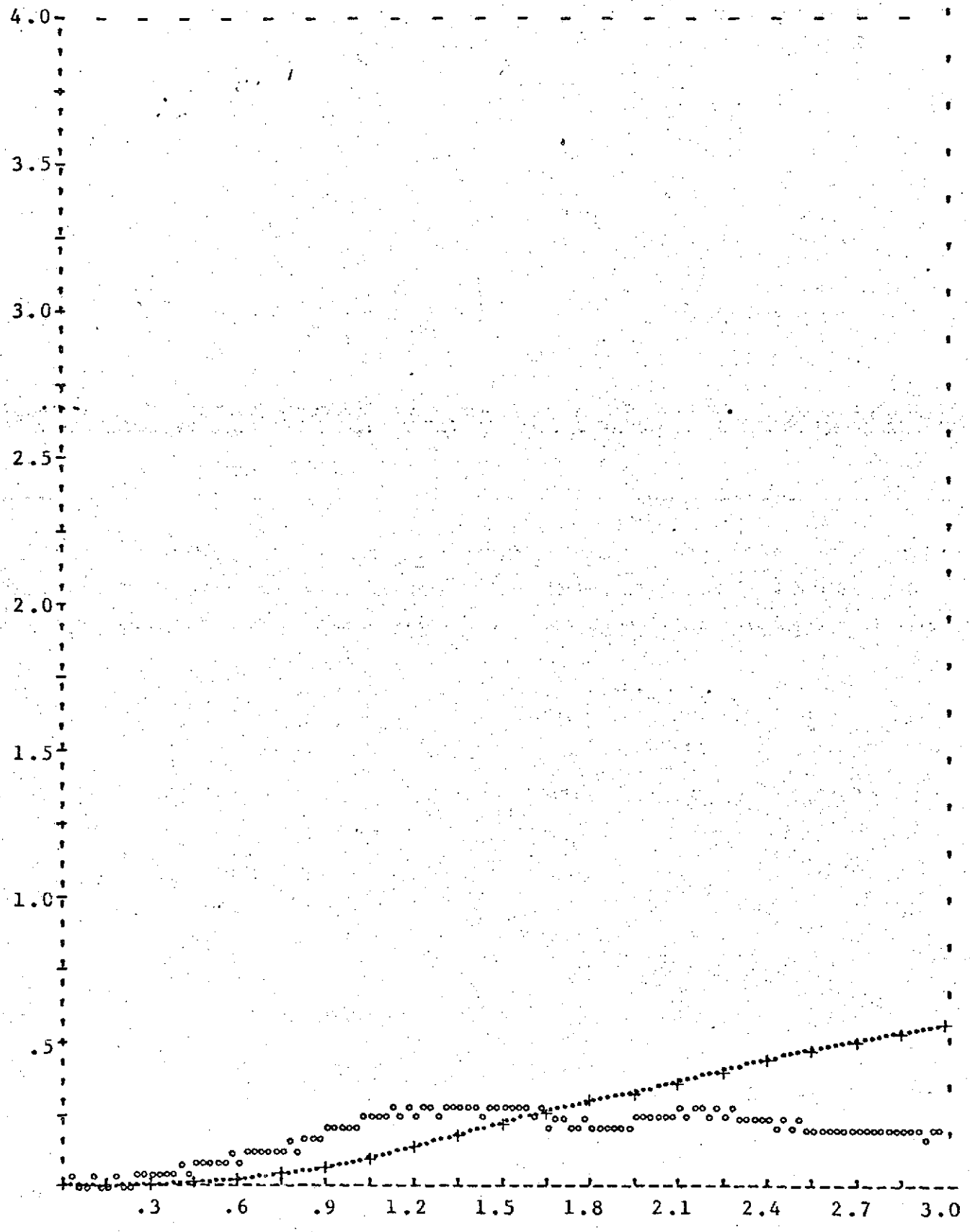
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB SCOTOR 20 fpm 68°F



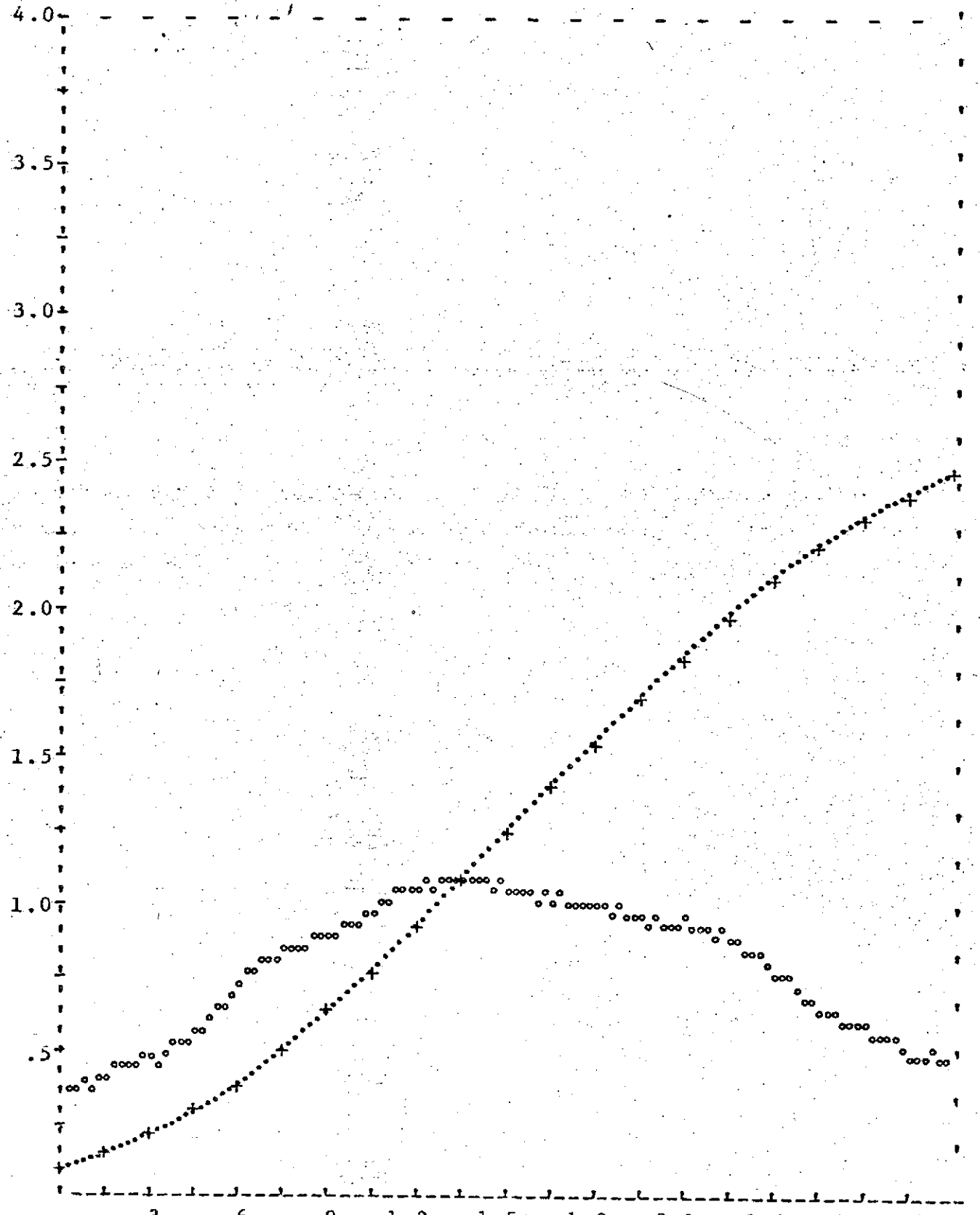
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB SCOlOR 40 fpm 68°F



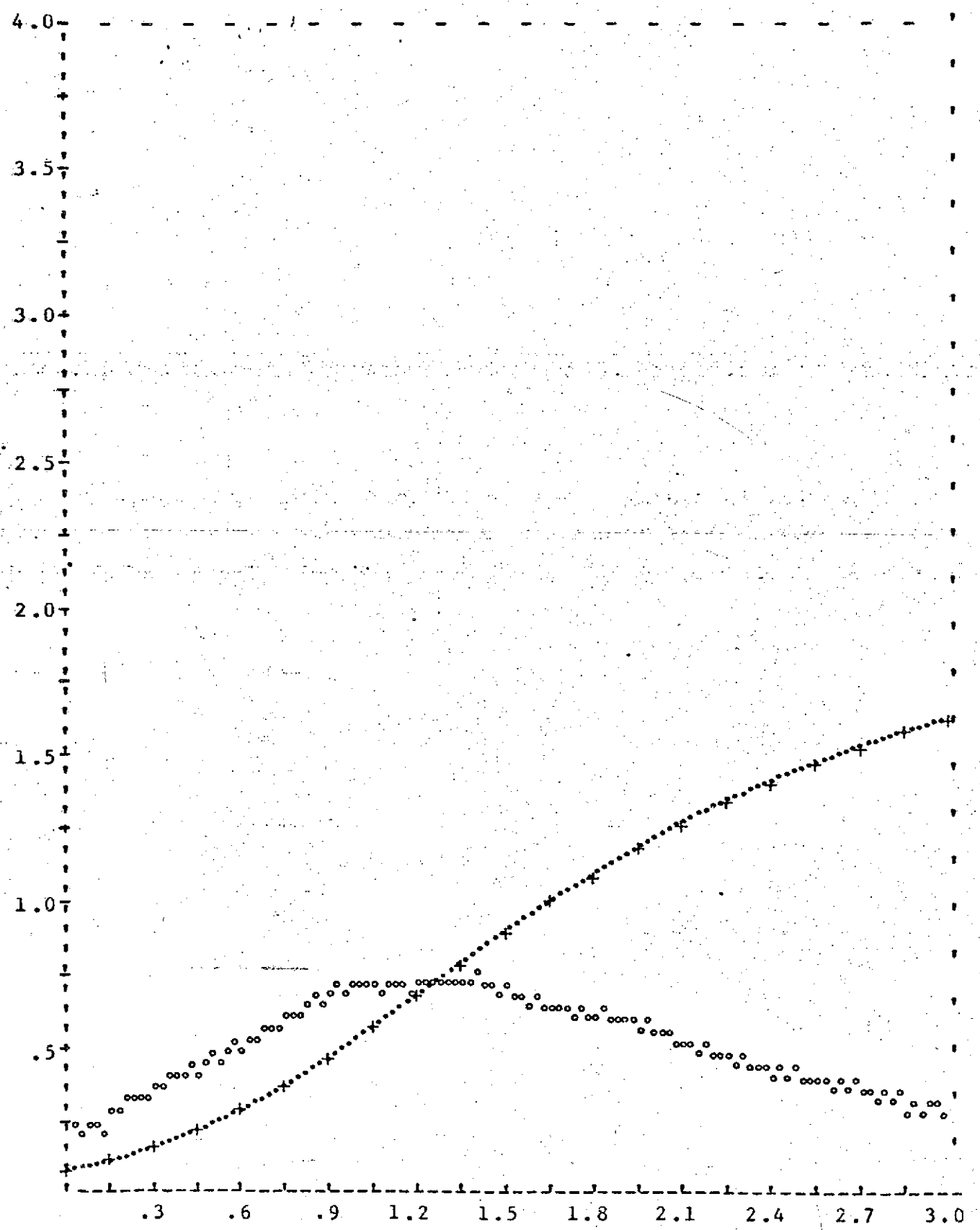
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB SCOlOR 10 fpm 80°F



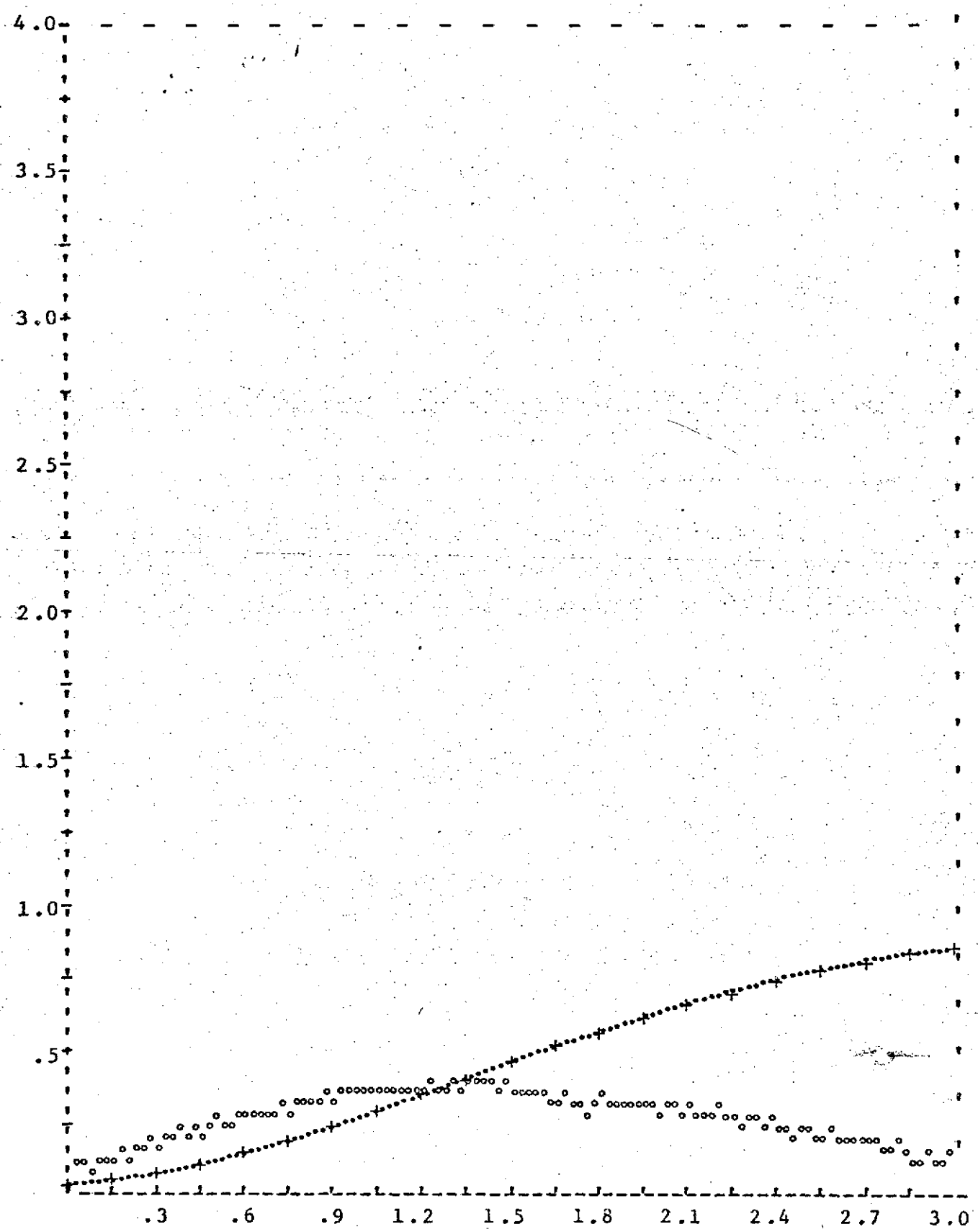
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB SCOlOR 20 fpm 80°F



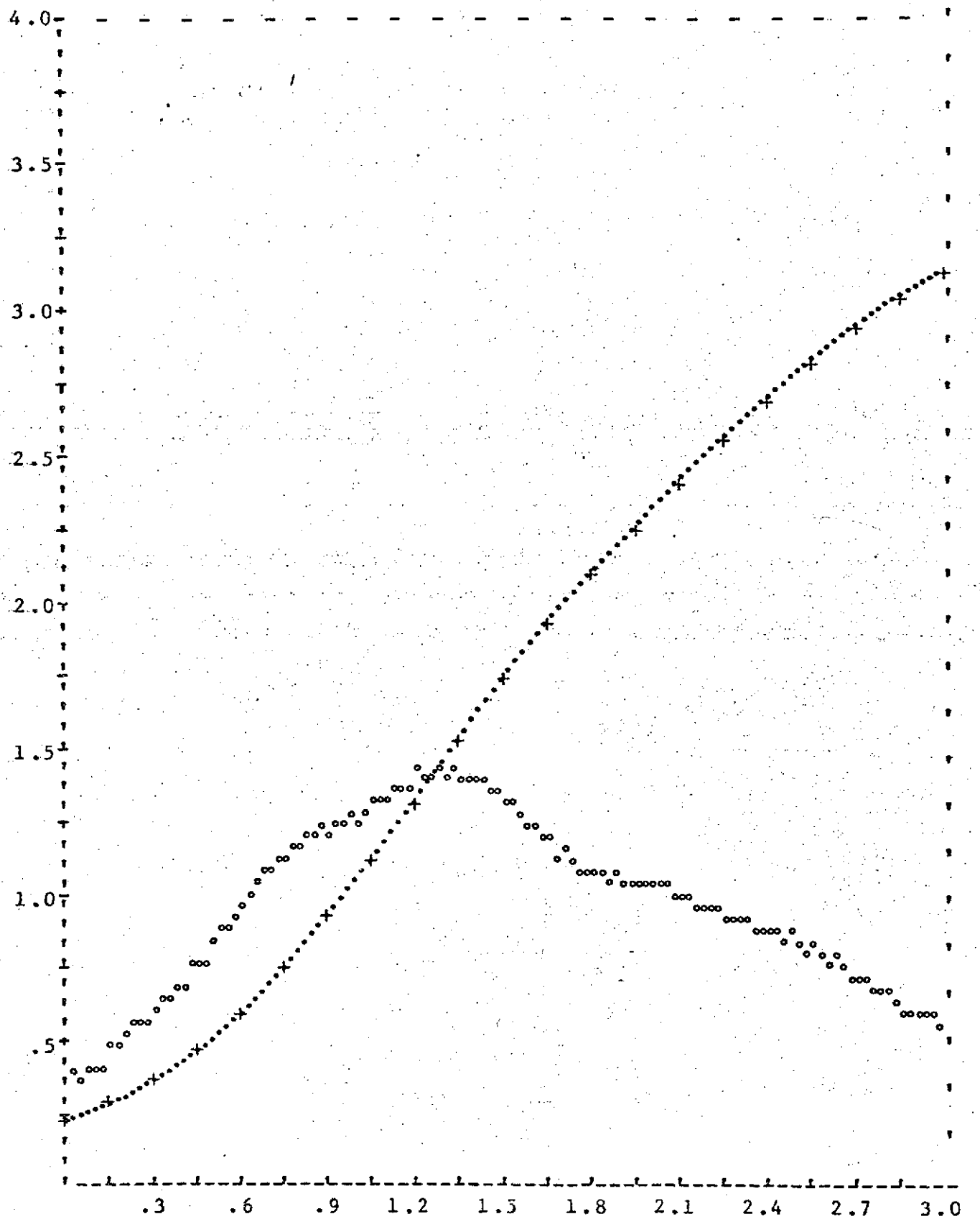
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB SCOlOR 40 fpm 80°F



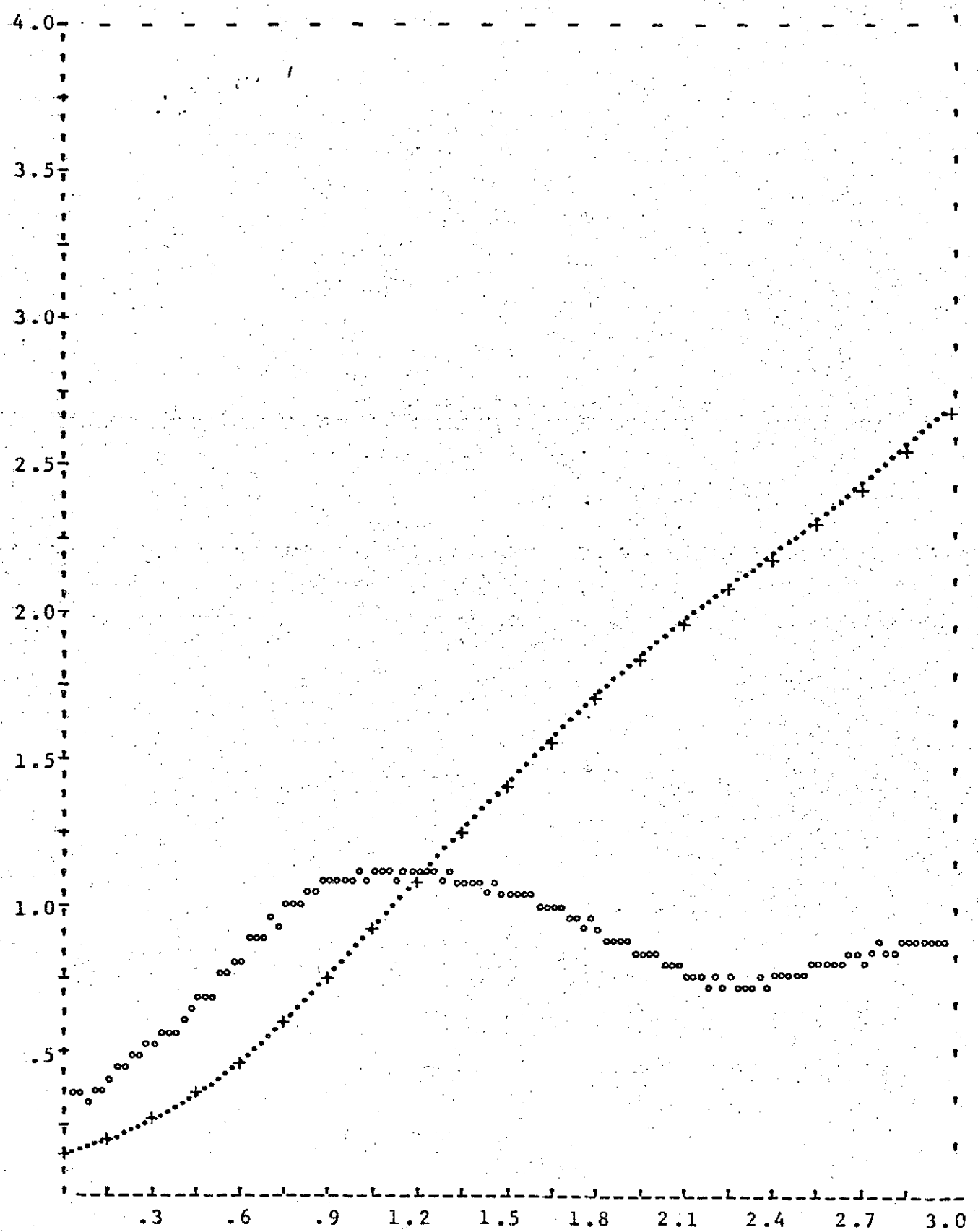
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB MX-641 10 fpm 68°F



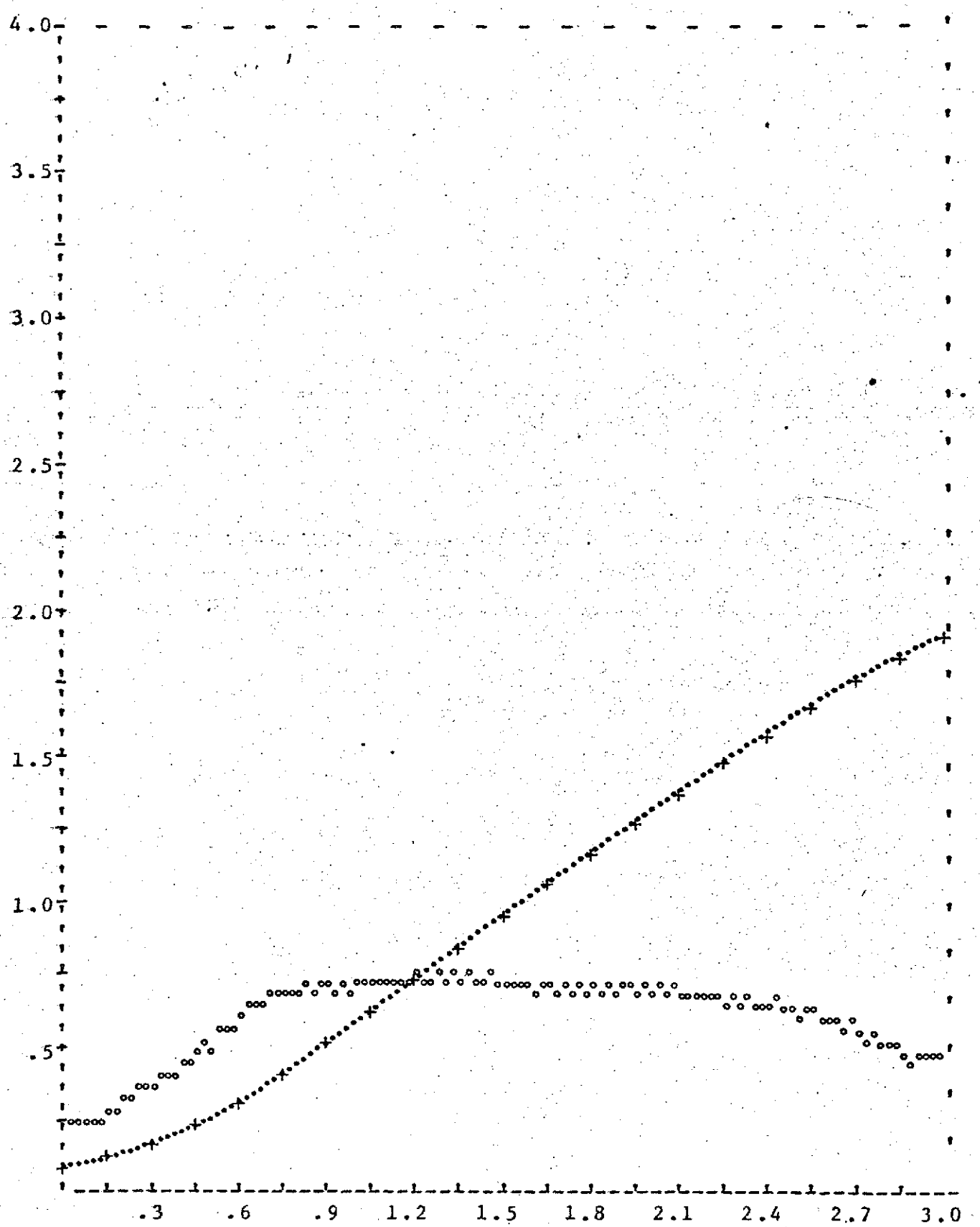
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB MX-641 20 fpm 68°F



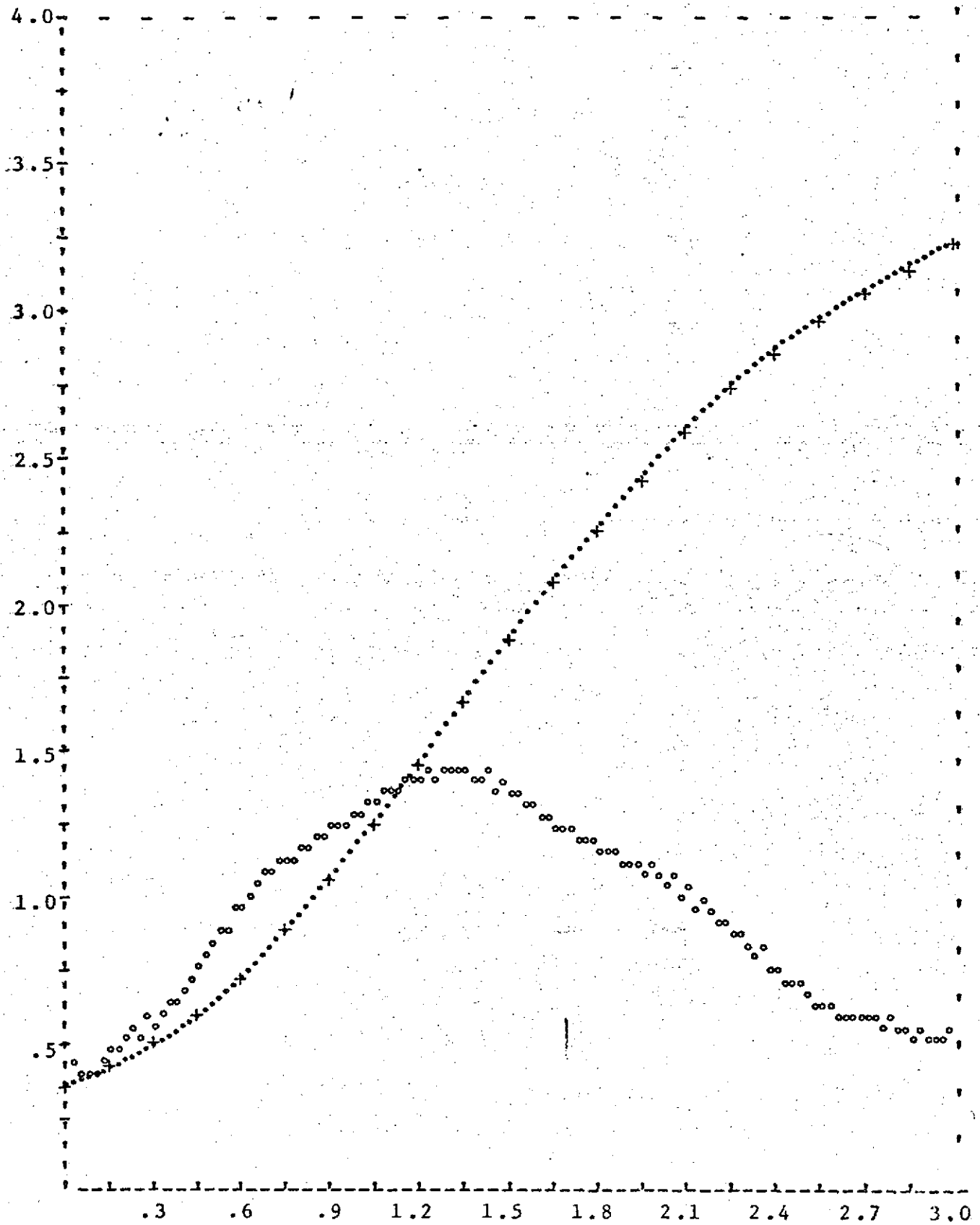
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB MX-641 40 fpm 68°F



TECHNICOLOR SENSITOMETRIC REPORT

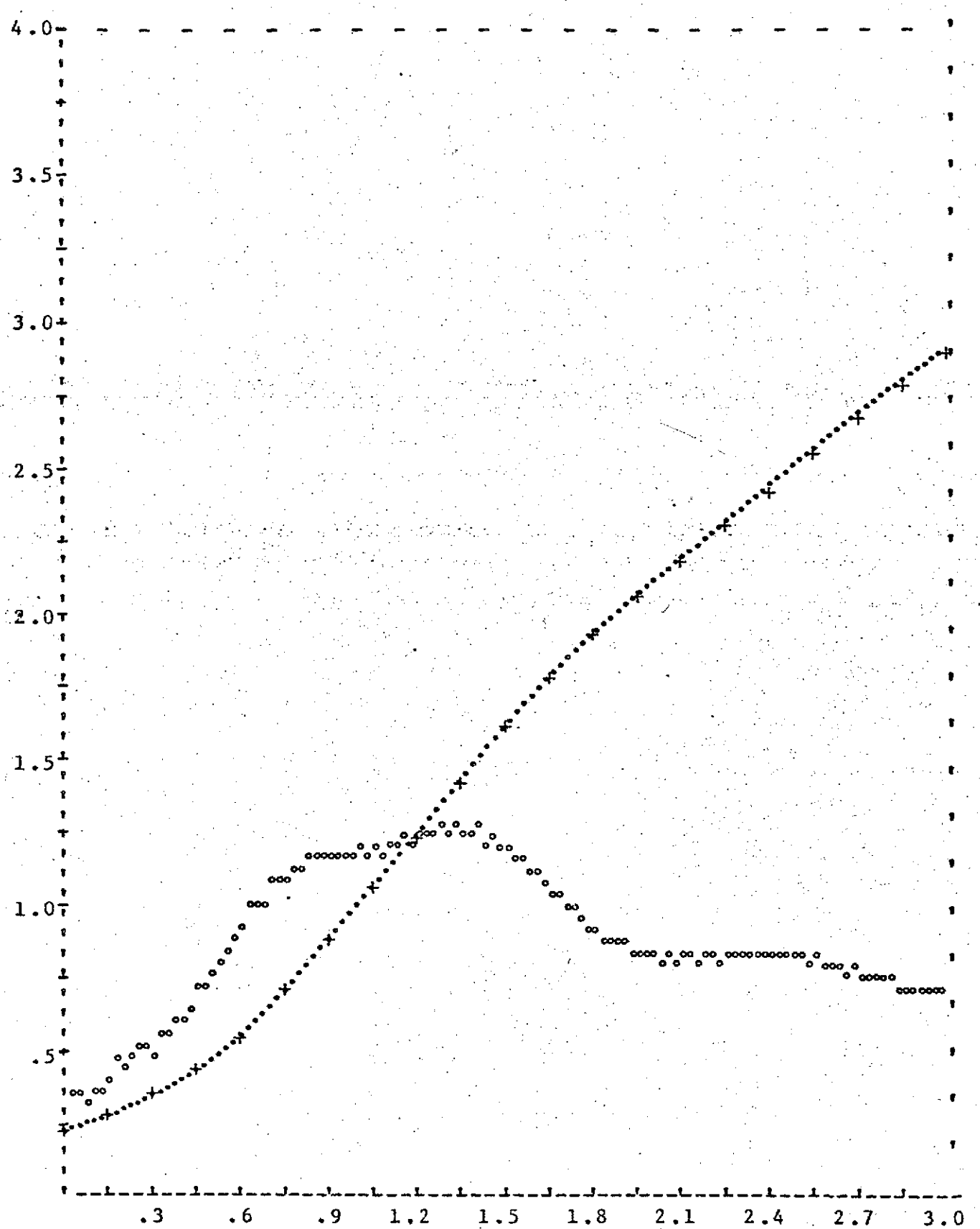
SR-112 IB MX-641 10 fpm 80°F



Gamma = 1.4000

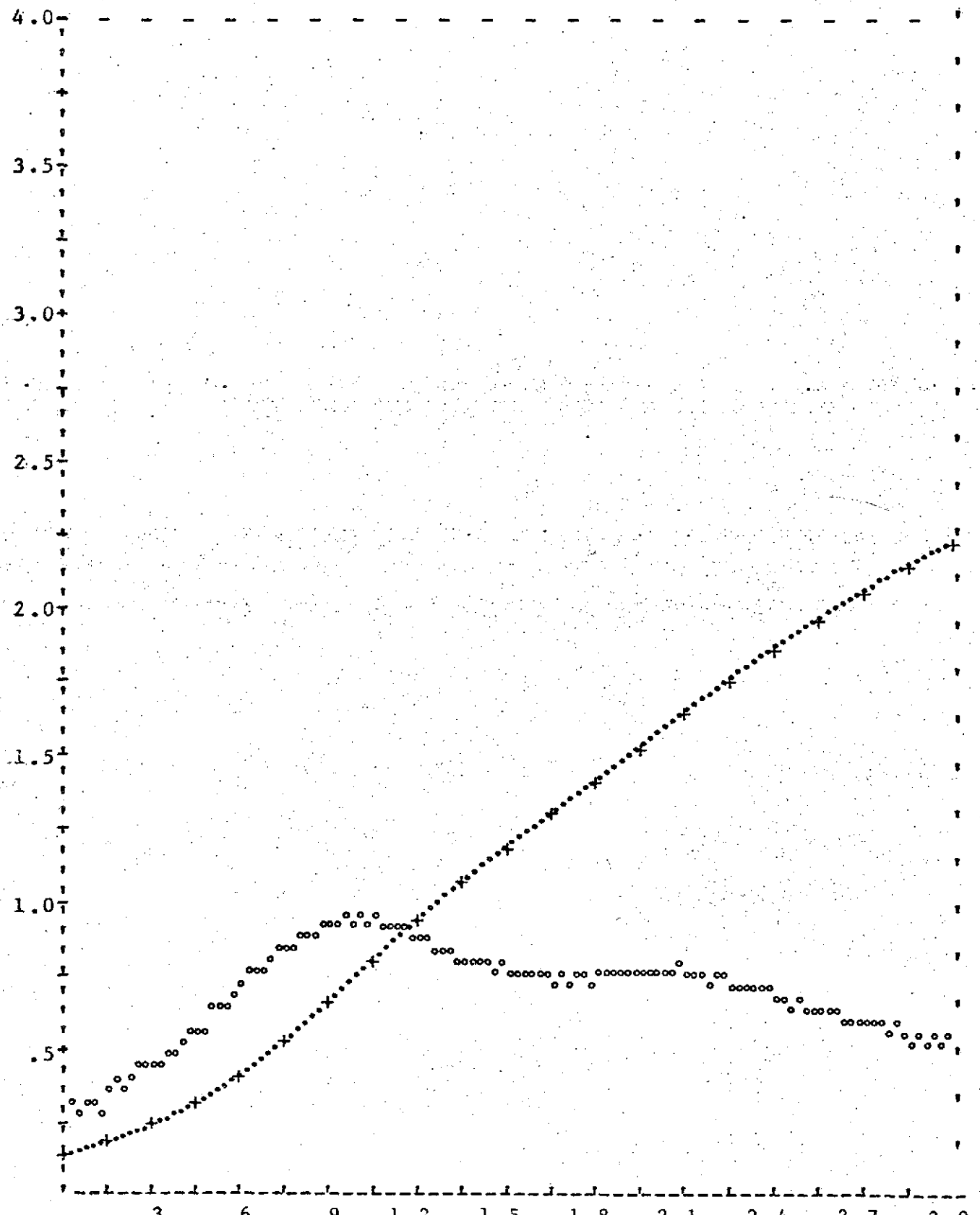
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB MX-641 20 fpm 80°F



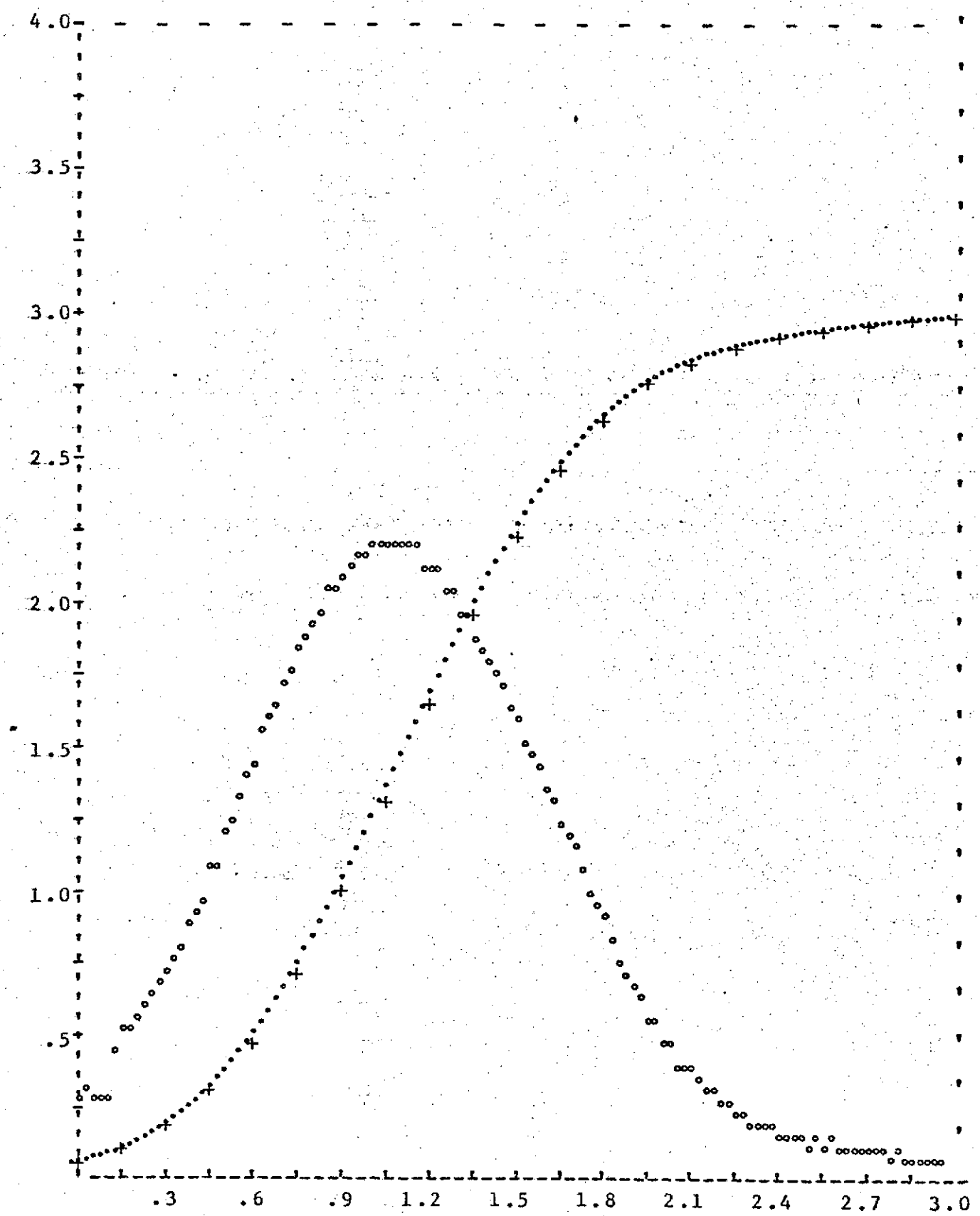
TECHNICOLOR SENSITOMETRIC REPORT

SR-112 IB MX-641 40 fpm 80°F



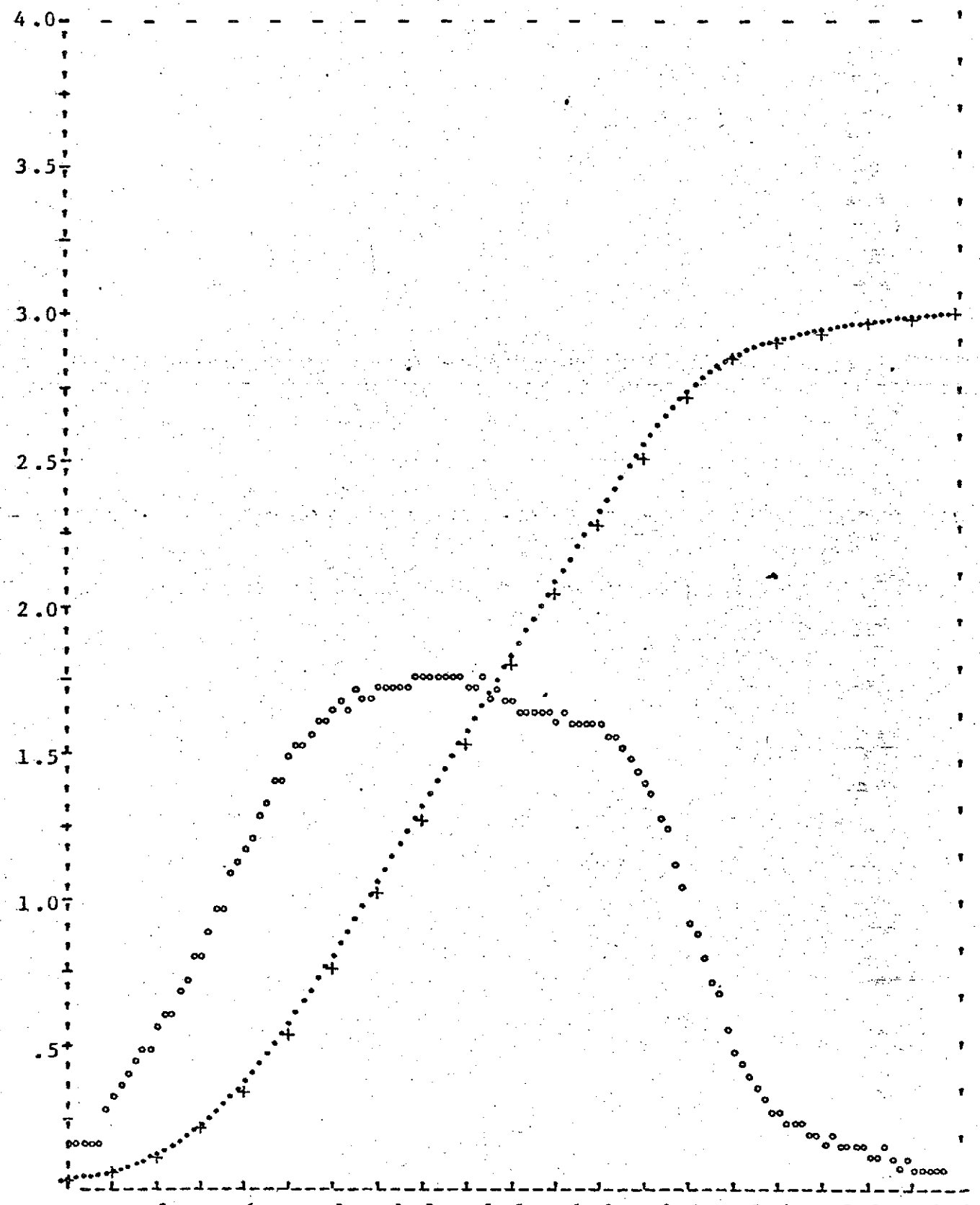
TECHNICOLOR SENSITOMETRIC REPORT

2430-178 IB MX-641 10 fpm 68°F



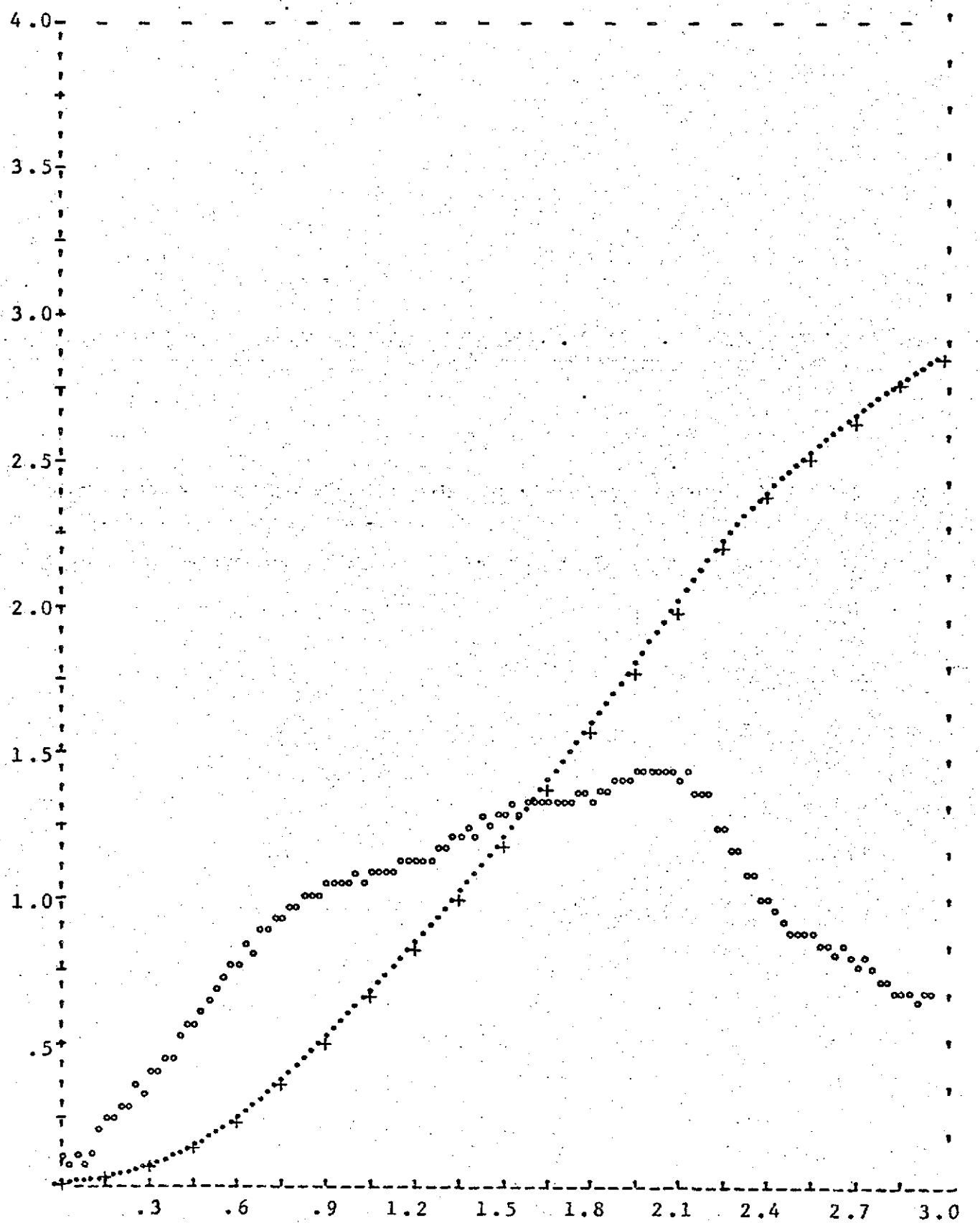
TECHNICOLOR SENSITOMETRIC REPORT

2430-178 IB MX-641 20 fpm 68°F



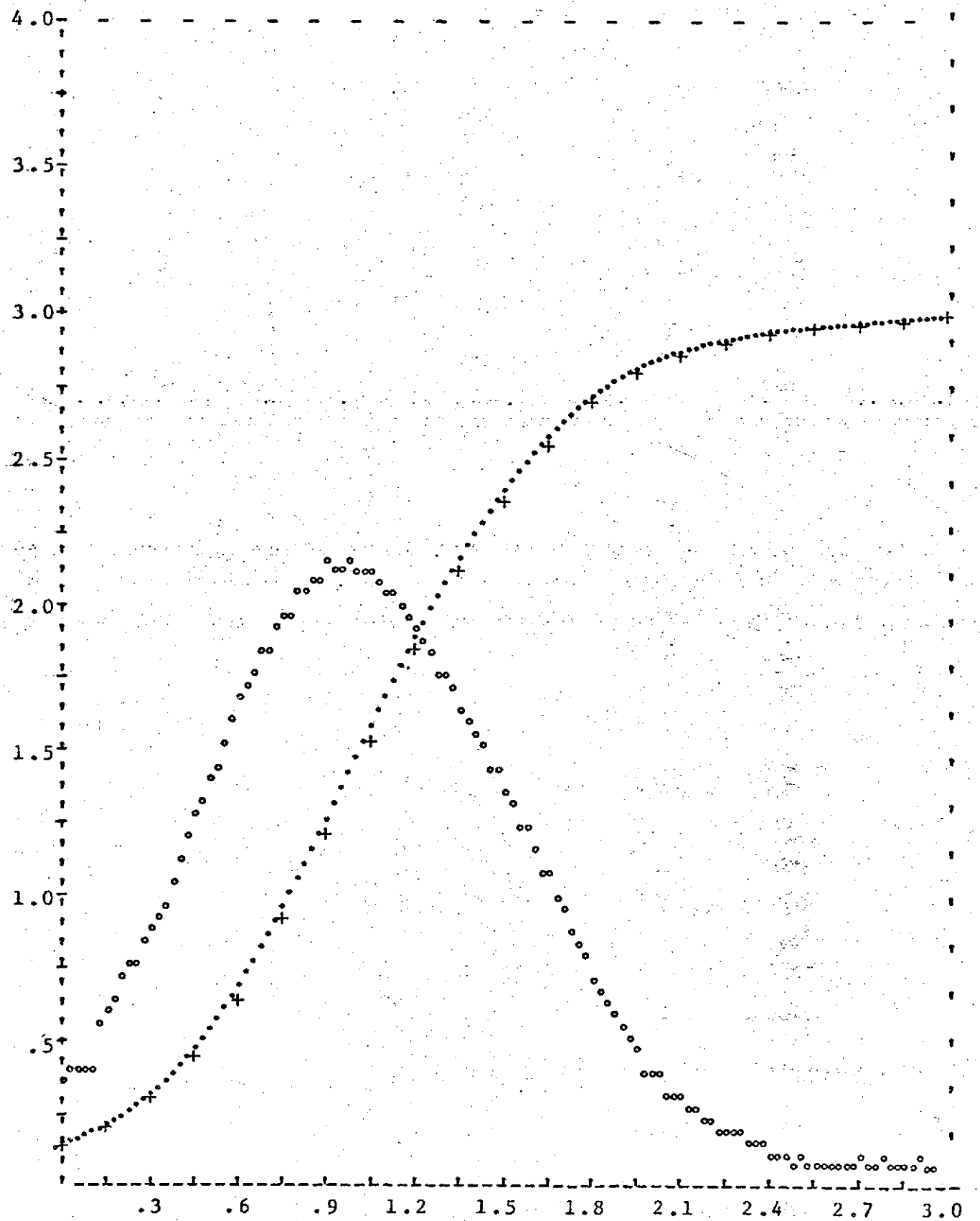
TECHNICOLOR SENSITOMETRIC REPORT

2430-178 IB MX-641 40 fpm 68°F



TECHNICOLOR SENSITOMETRIC REPORT

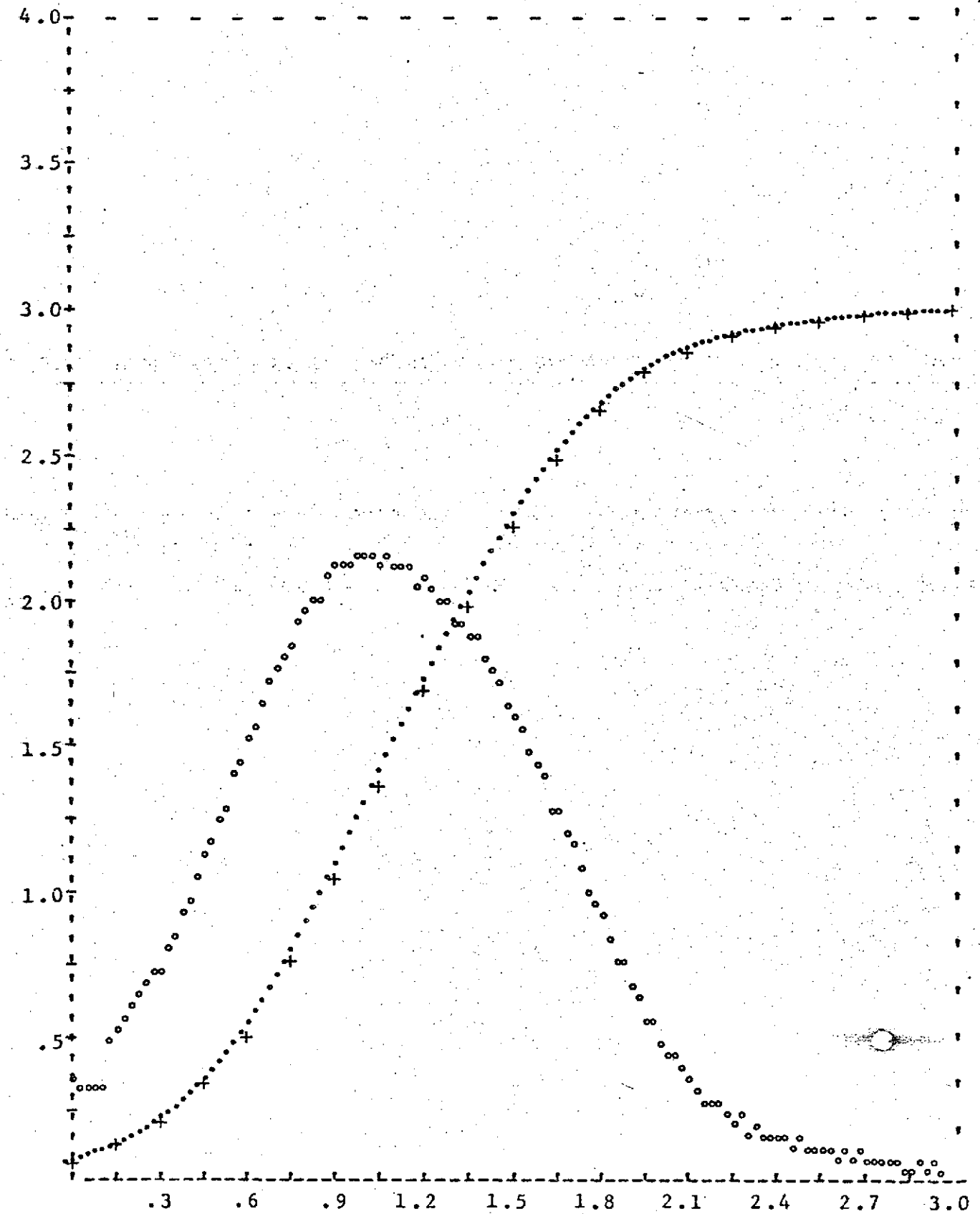
2430-178 IB MX641 10 fpm 80°F



Gamma = 2.0644

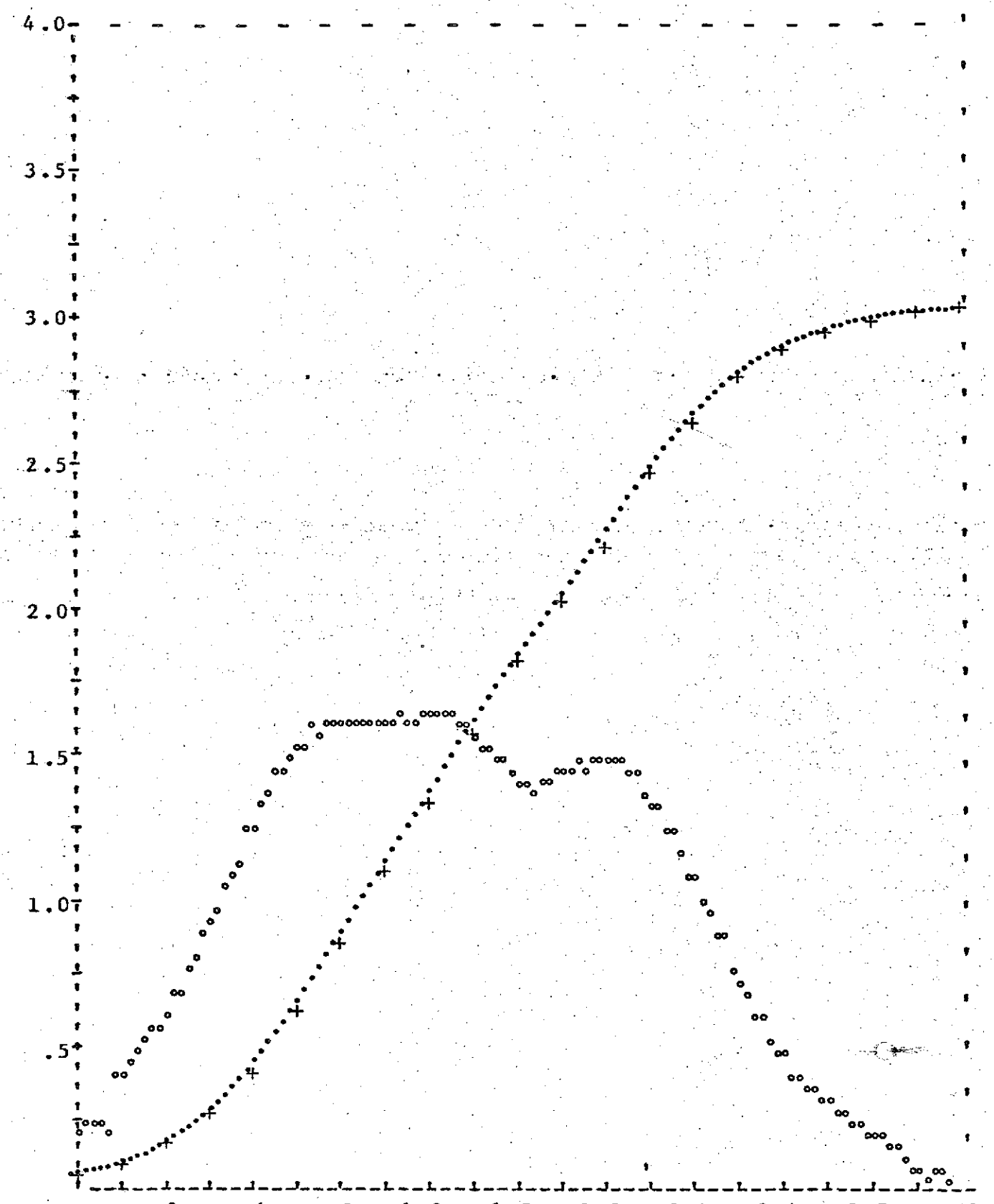
TECHNICOLOR SENSITOMETRIC REPORT

2430-178 IB MX-641 20 fpm 80°F



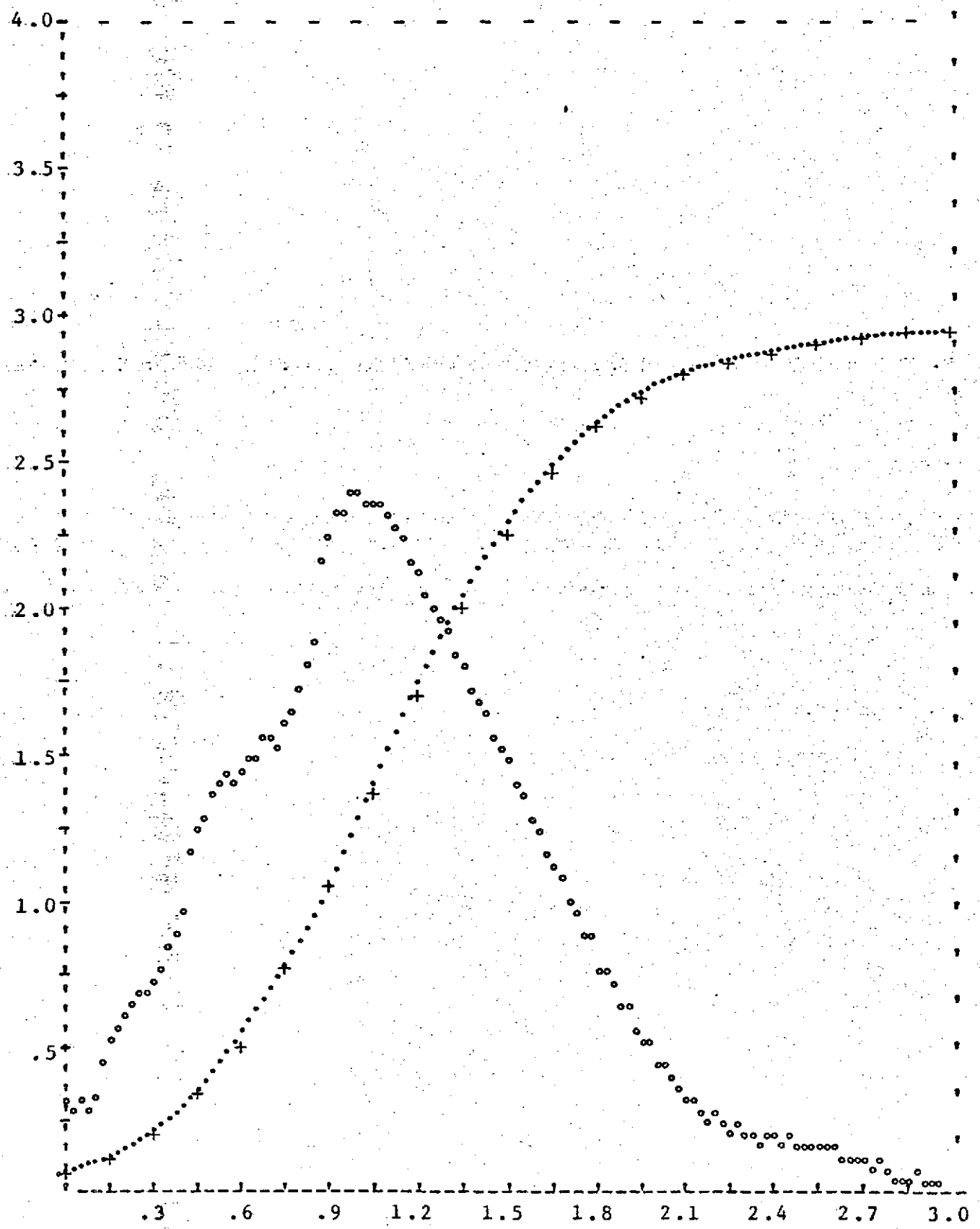
TECHNICOLOR SENSITOMETRIC REPORT

2430-178 IB MX-641 40 fpm 80°F



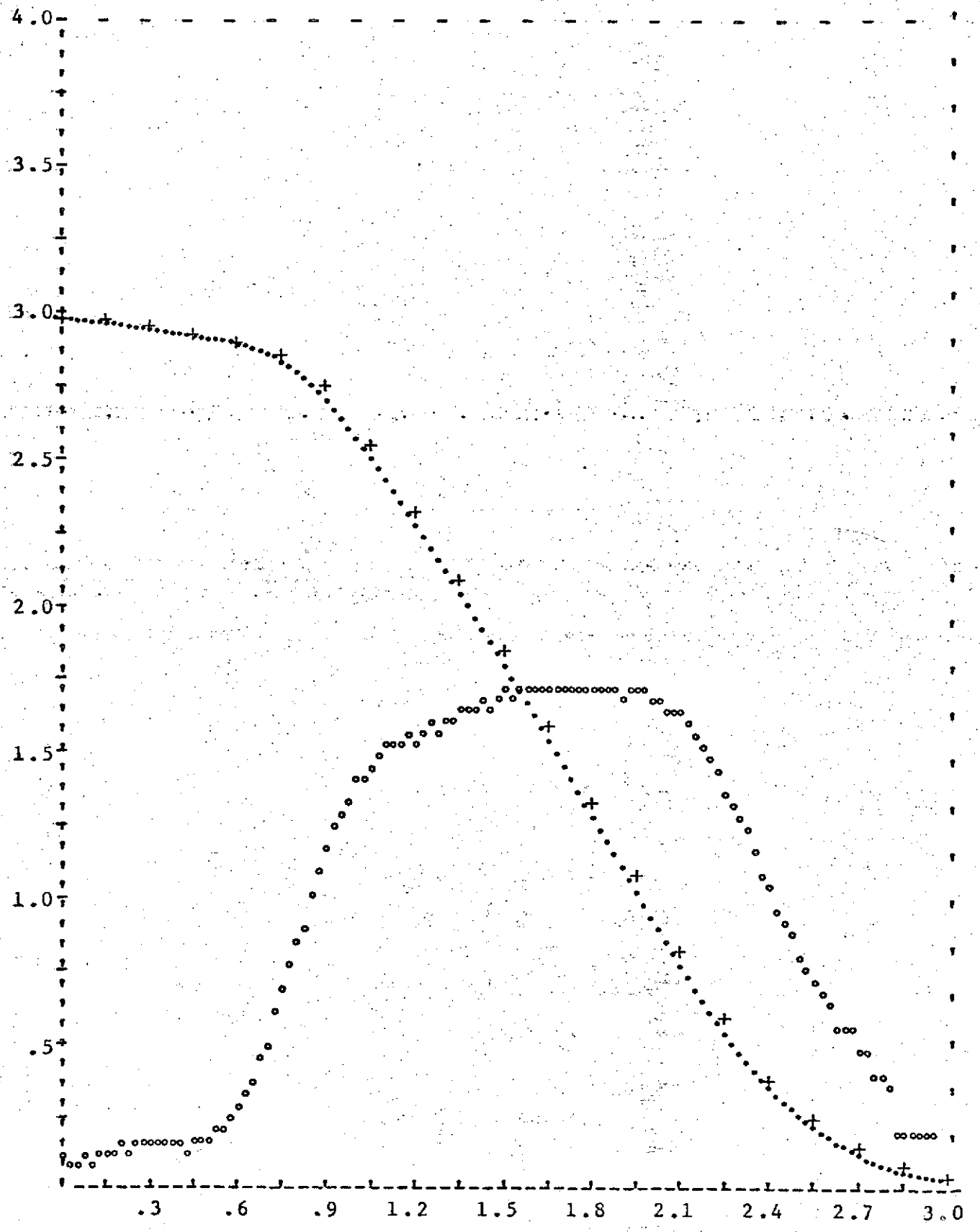
TECHNICOLOR SENSITOMETRIC REPORT

2430-175 IB MX-641 10 fpm 68 deg.



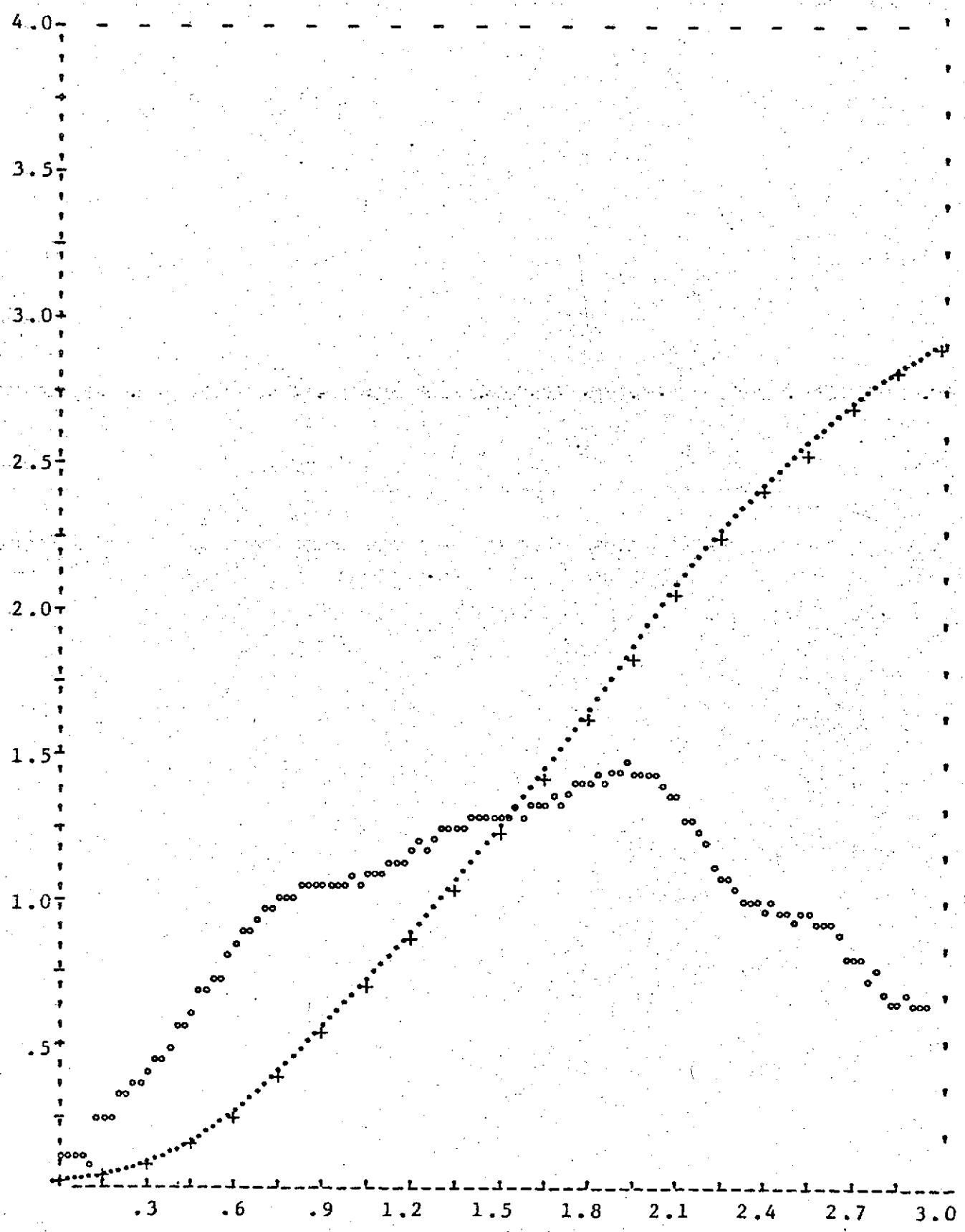
TECHNICOLOR SENSITOMETRIC REPORT

2430-175 IB MX-641 20 fpm 68 deg.



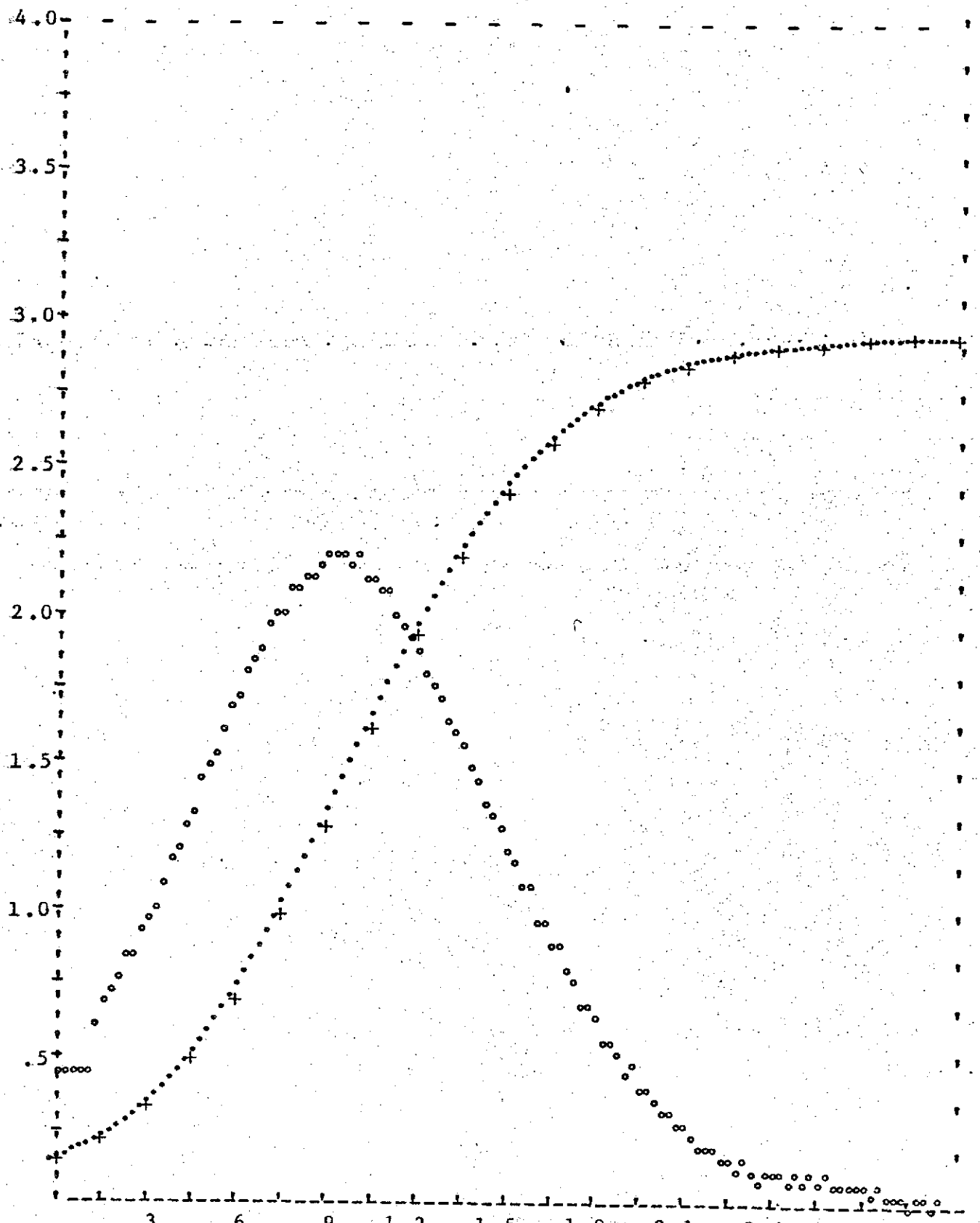
TECHNICOLOR SENSITOMETRIC REPORT

2430-175 IB MX-641 40 fpm 68°F



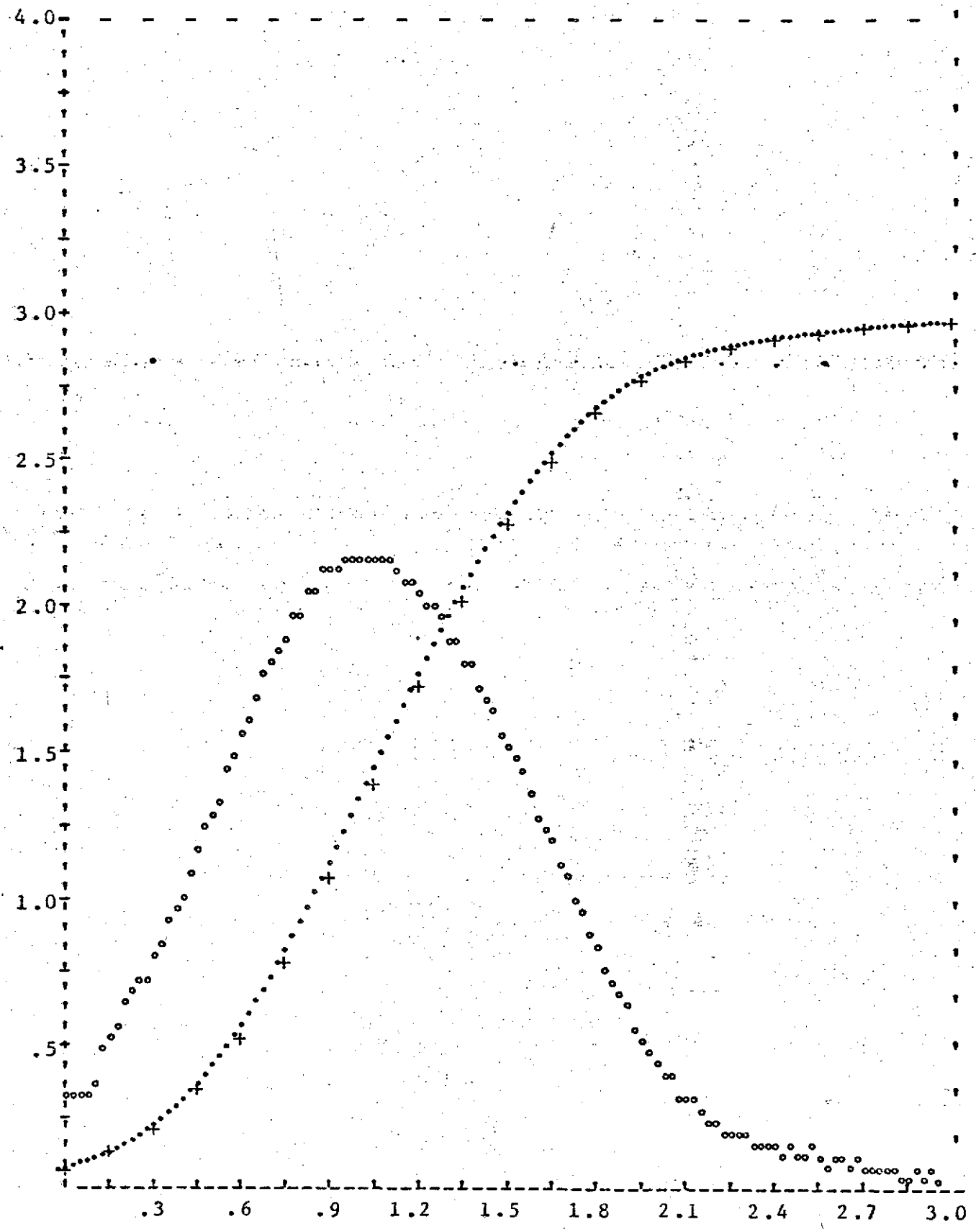
TECHNICOLOR SENSITOMETRIC REPORT

2430-175 IB MX-641 10 fpm 80°F



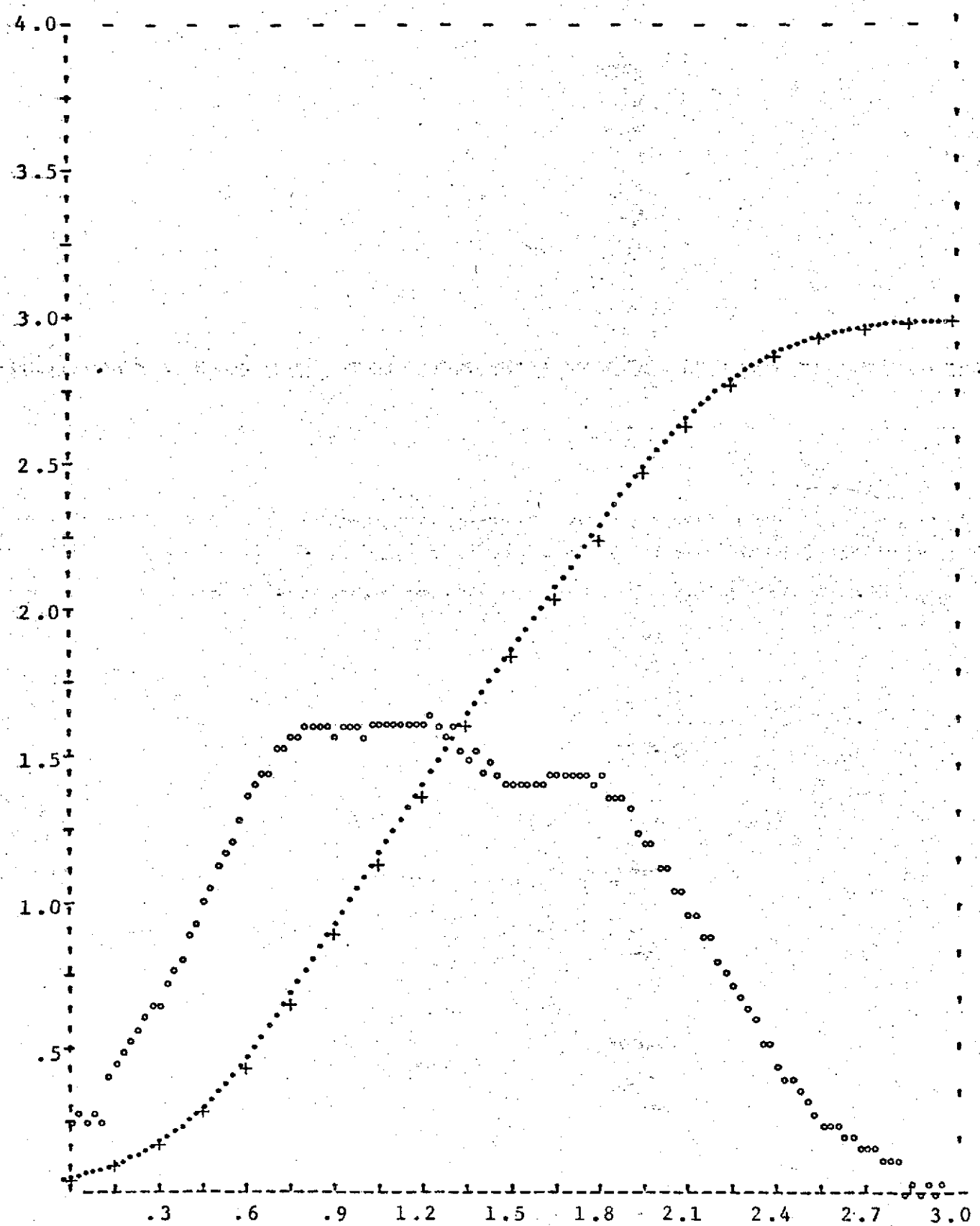
TECHNICOLOR SENSITOMETRIC REPORT

2430-175 IB MX-641 20 fpm 80°F



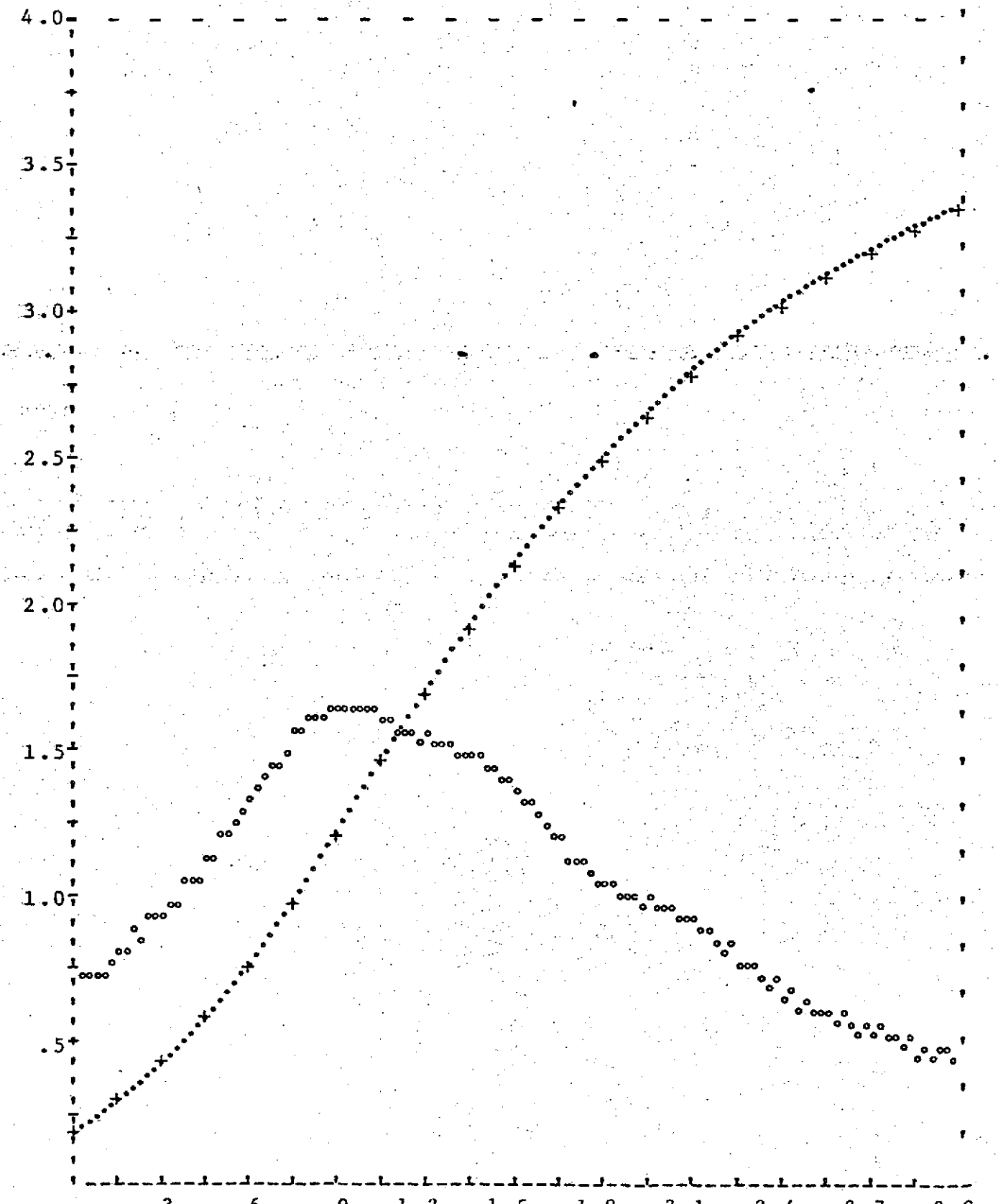
TECHNICOLOR SENSITOMETRIC REPORT

2430-175 IB MX-641 40 fpm 80°F



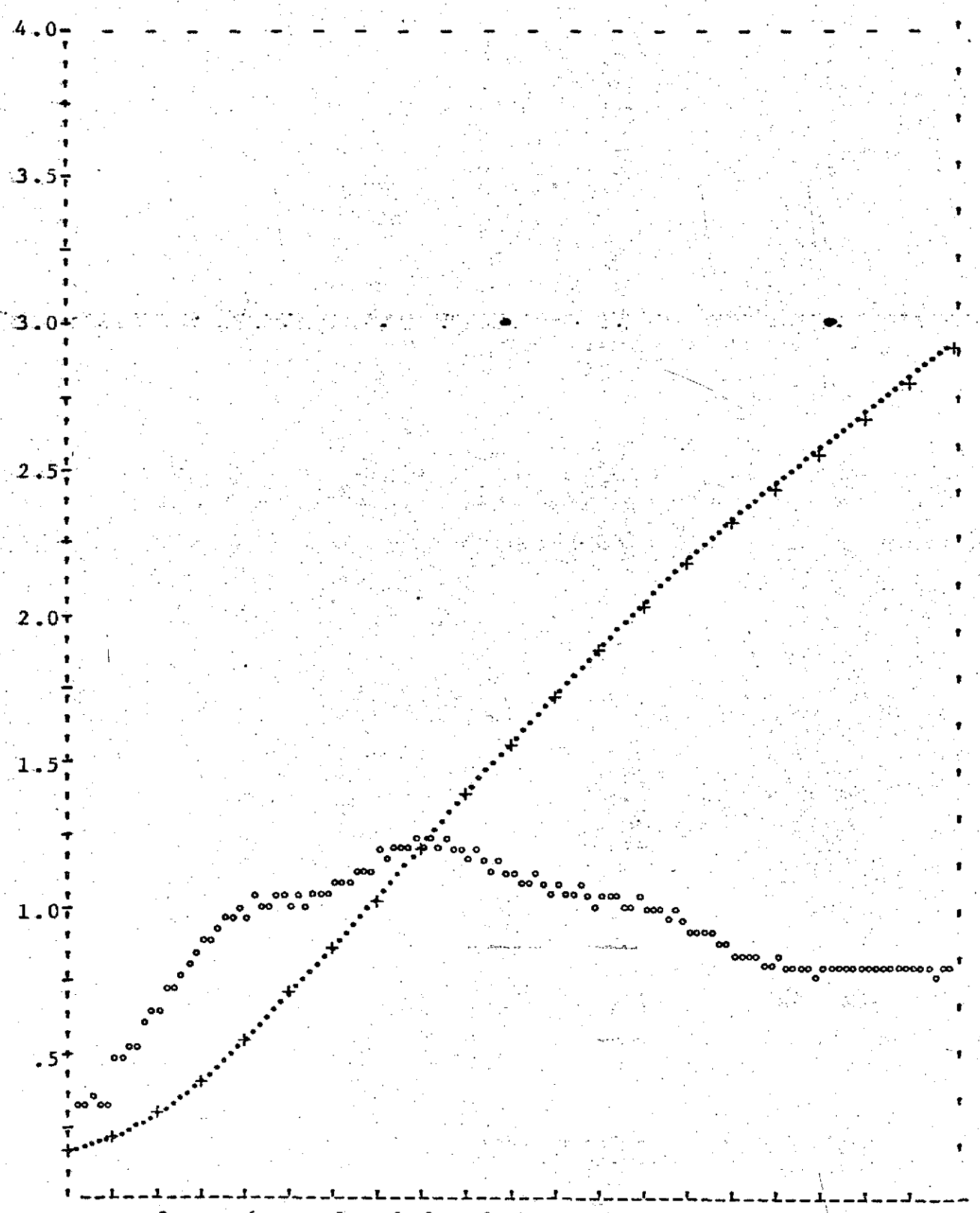
TECHNICOLOR SENSITOMETRIC REPORT

FE-2628 IB MX--641 10 fpm 68°F



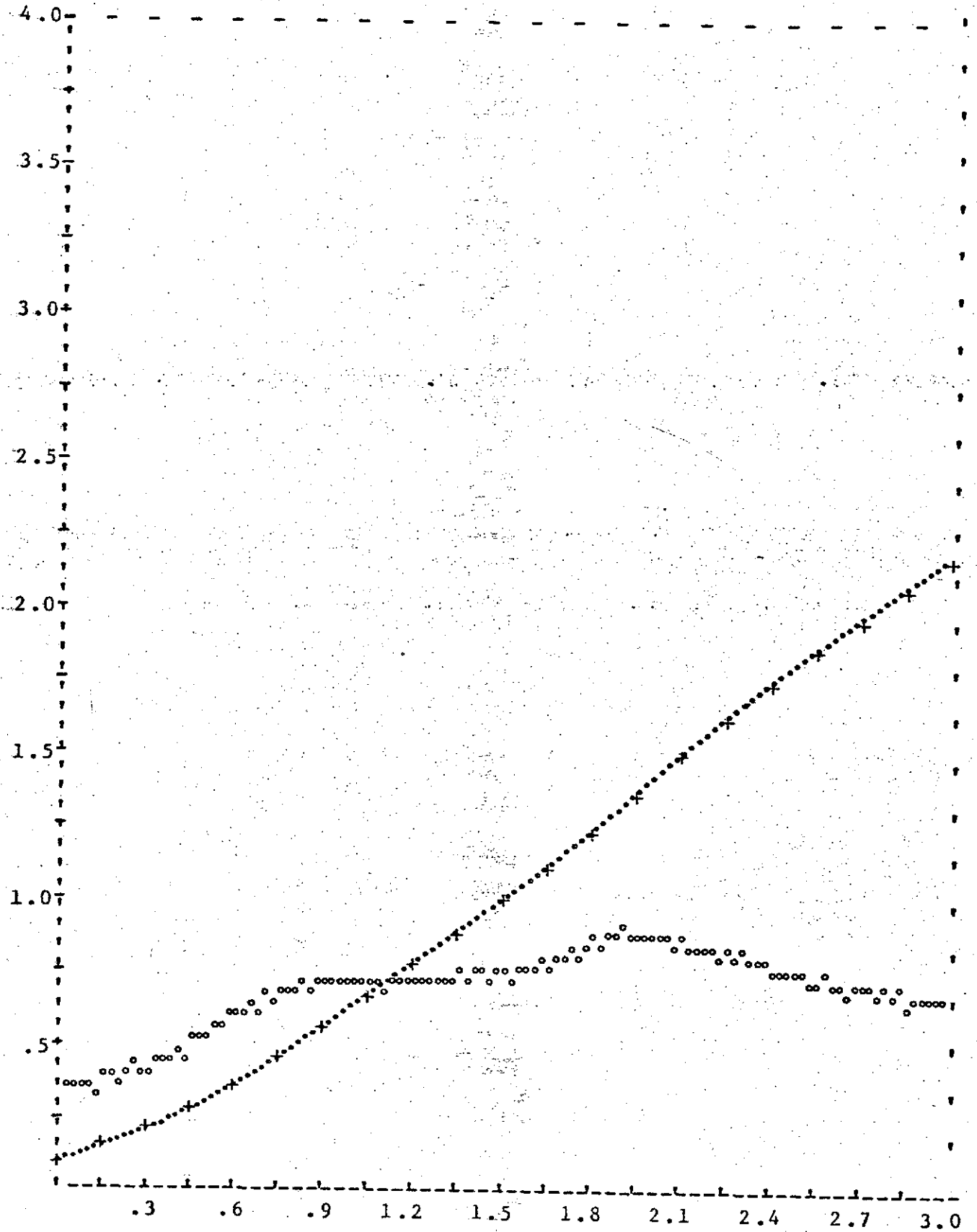
TECHNICOLOR SENSITOMETRIC REPORT

FE-2628 IB MX-641 20 fpm 68°F



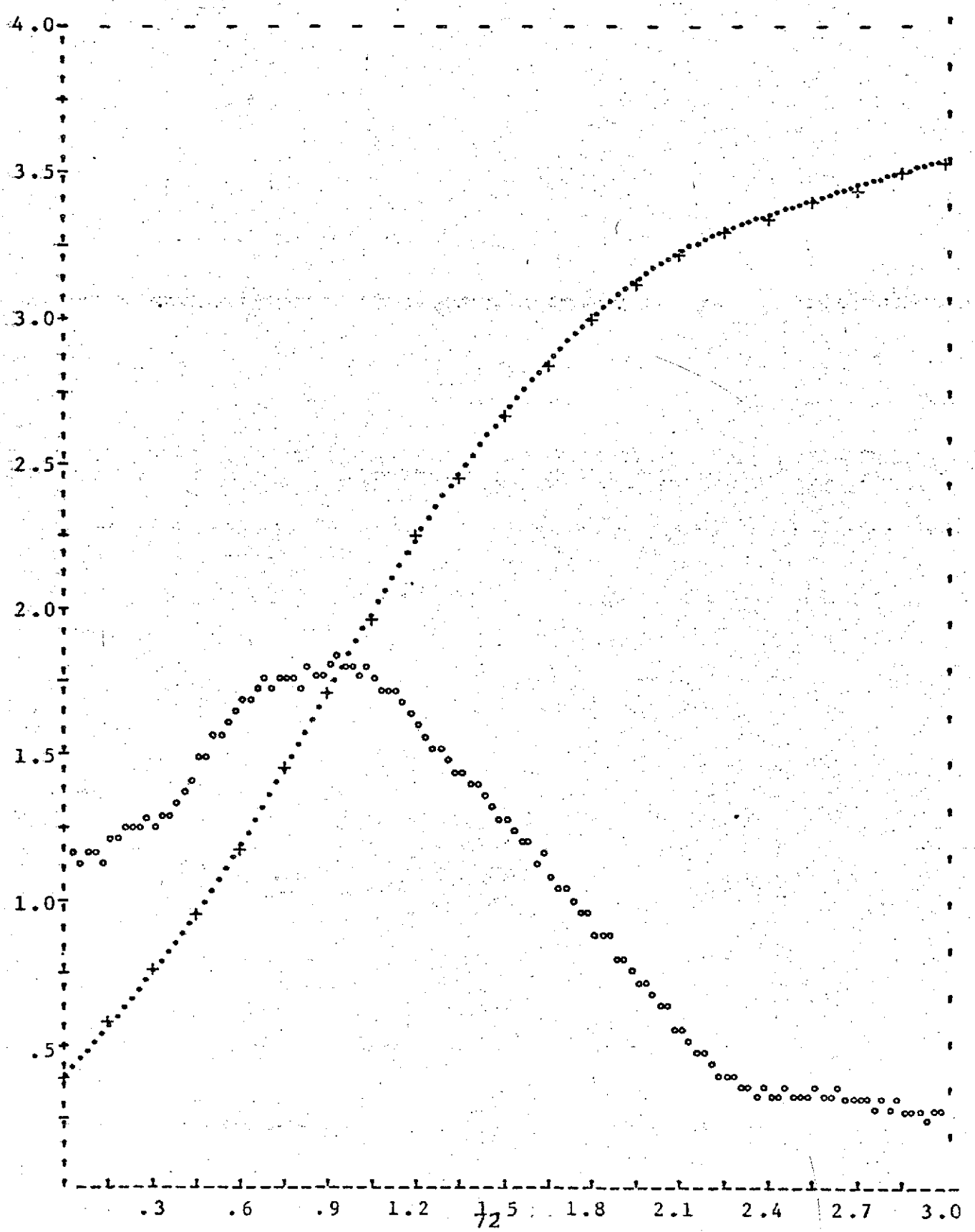
TECHNICOLOR SENSITOMETRIC REPORT

FE-2628 IB MX-641 40 fpm 68°F



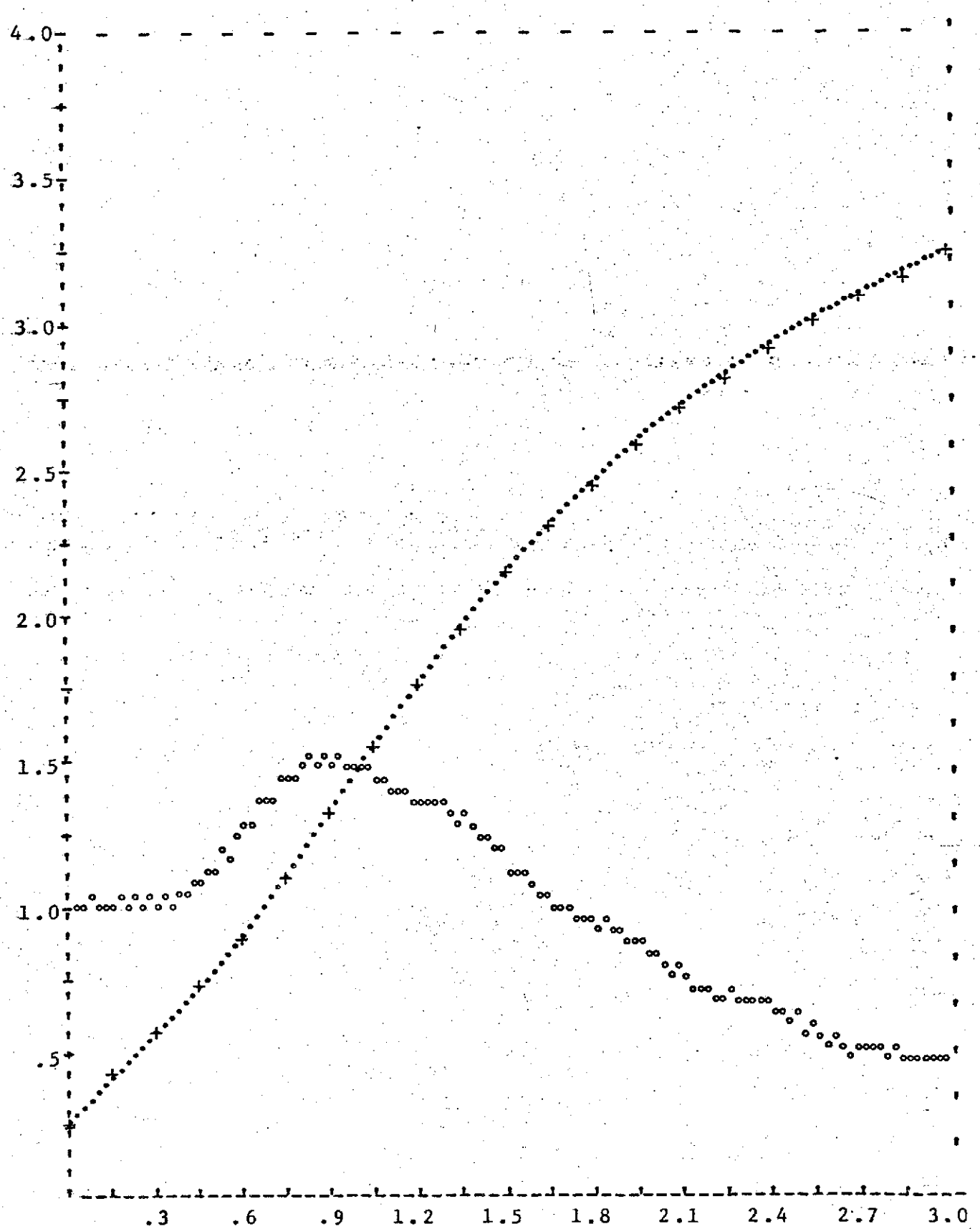
TECHNICOLOR SENSITOMETRIC REPORT

FE-2628 IB MX-641 10 fpm 80°f



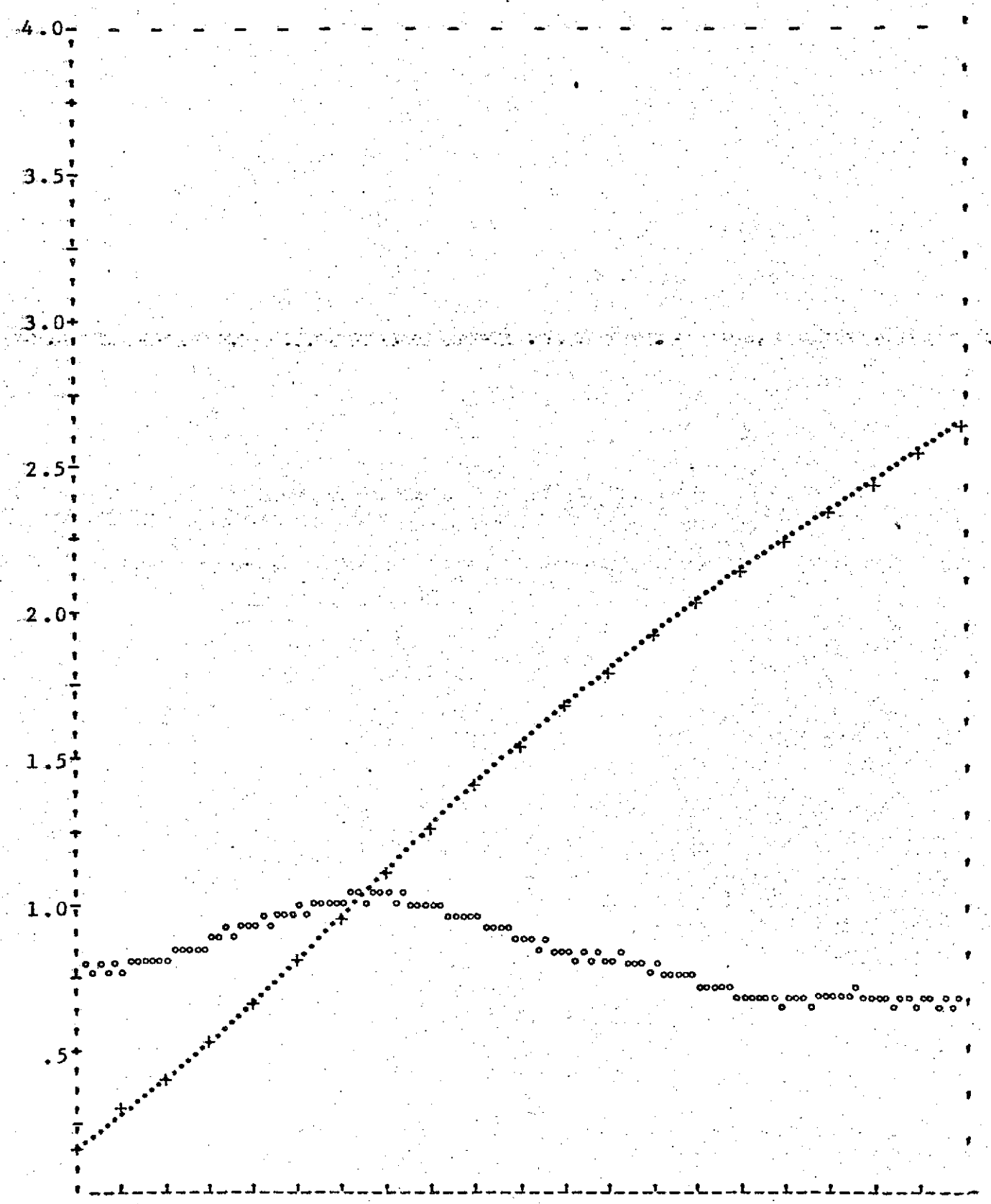
TECHNICOLOR SENSITOMETRIC REPORT

FE--2628 IB MX-641 20 fpm 80°F

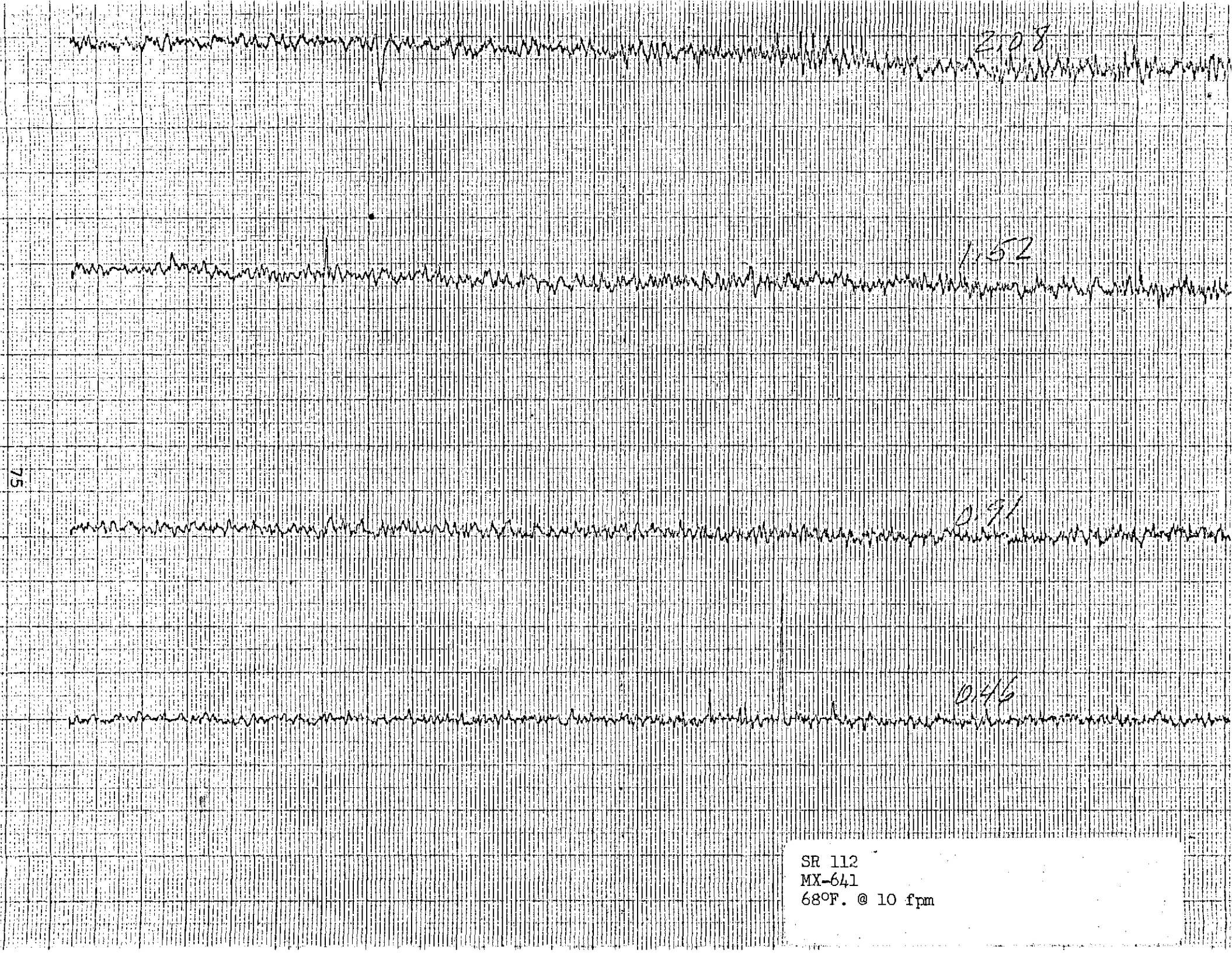


TECHNICOLOR SENSITOMETRIC REPORT

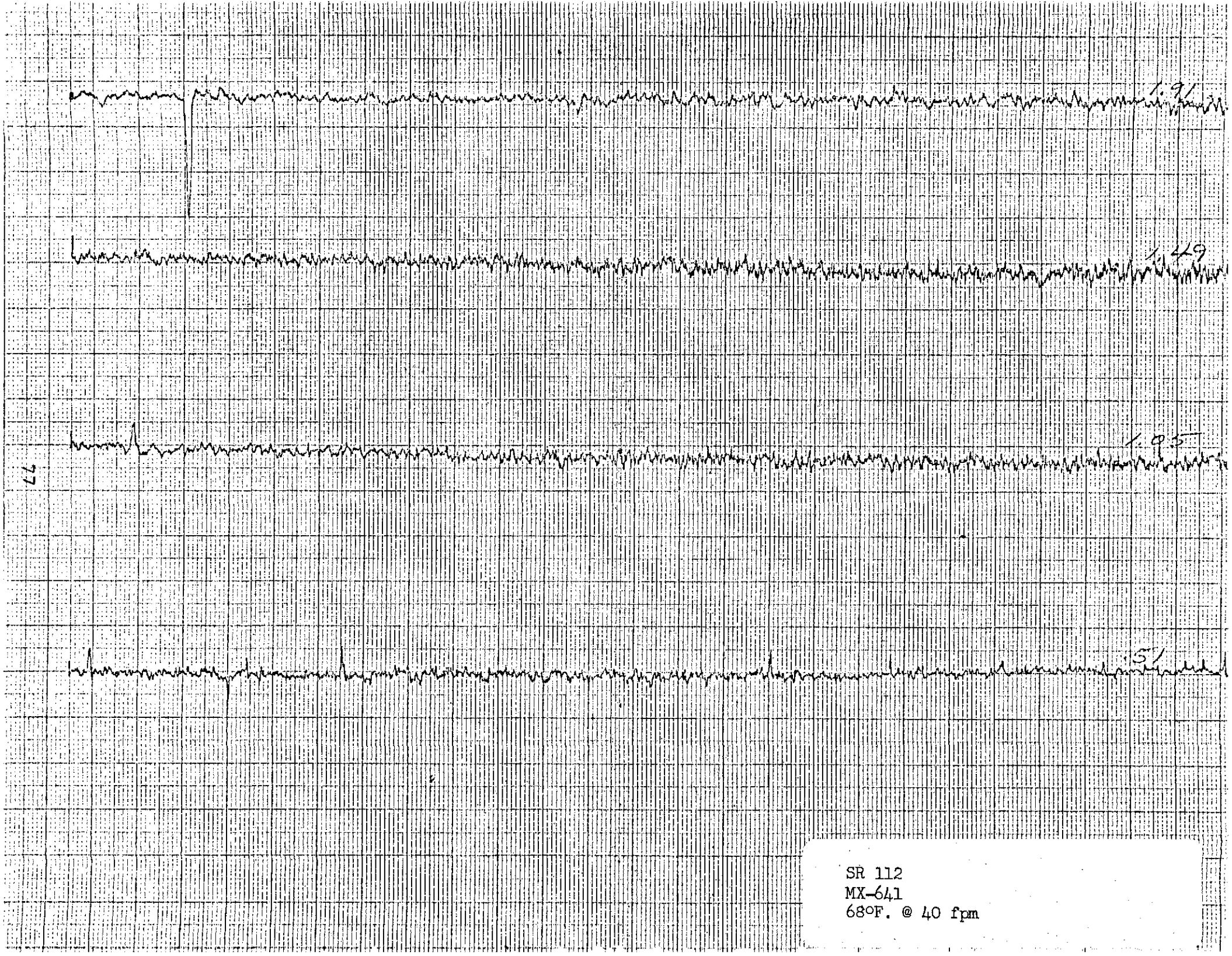
FE--2628 IB MX-641 40 fpm 80°F



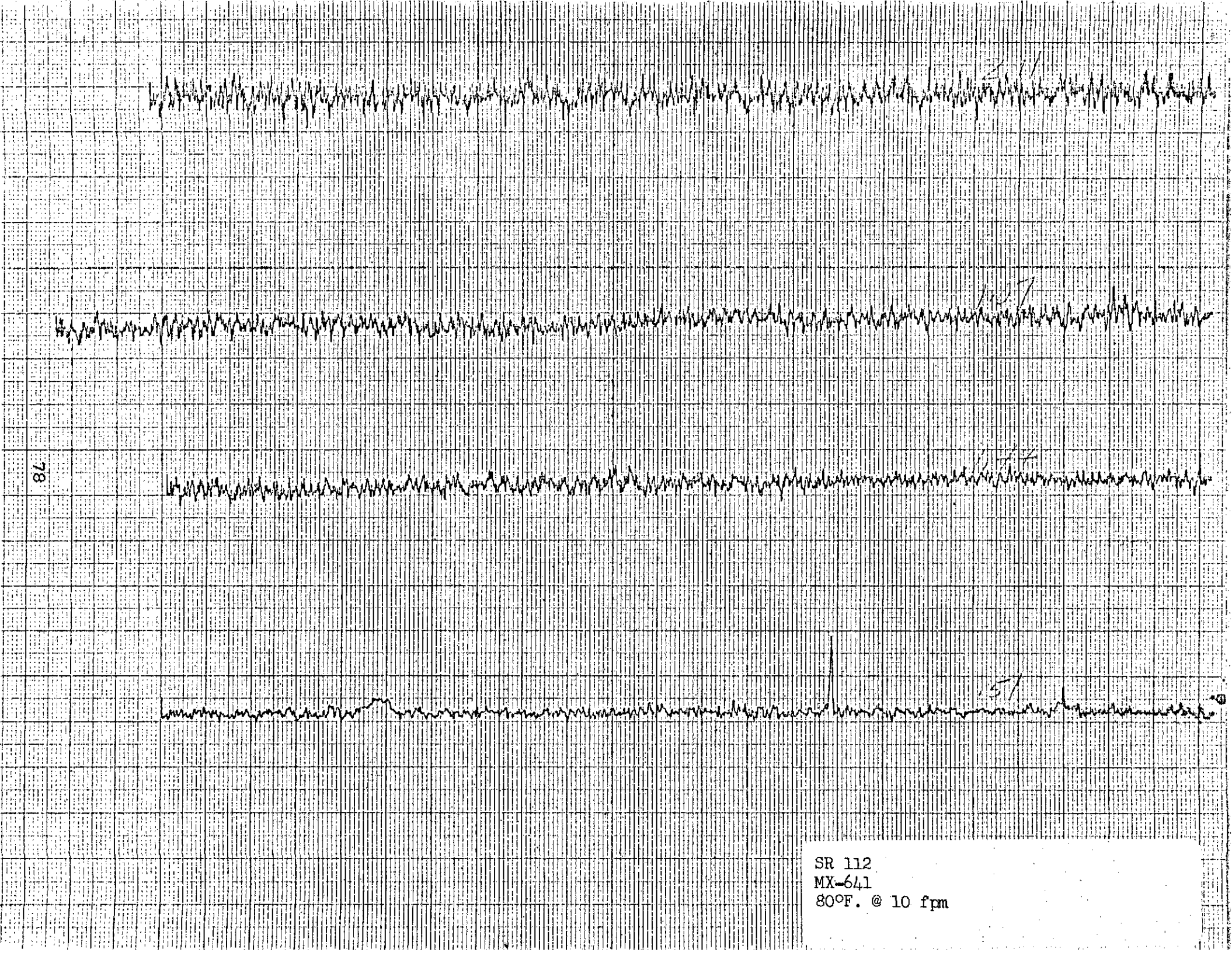
APPENDIX D

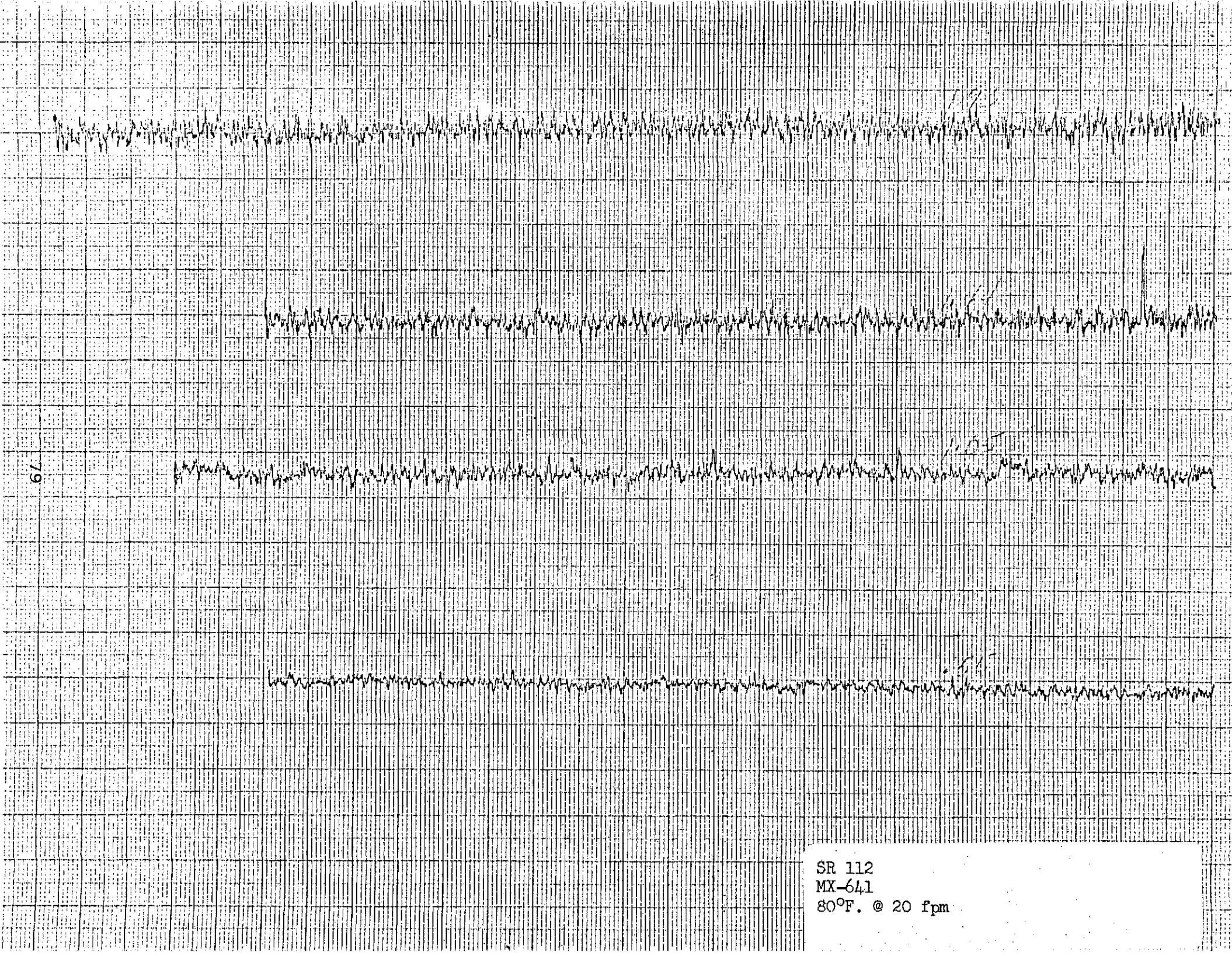

2.08
1.52
0.96
0.44
75
SR 112
MX-641
68°F. @ 10 fpm

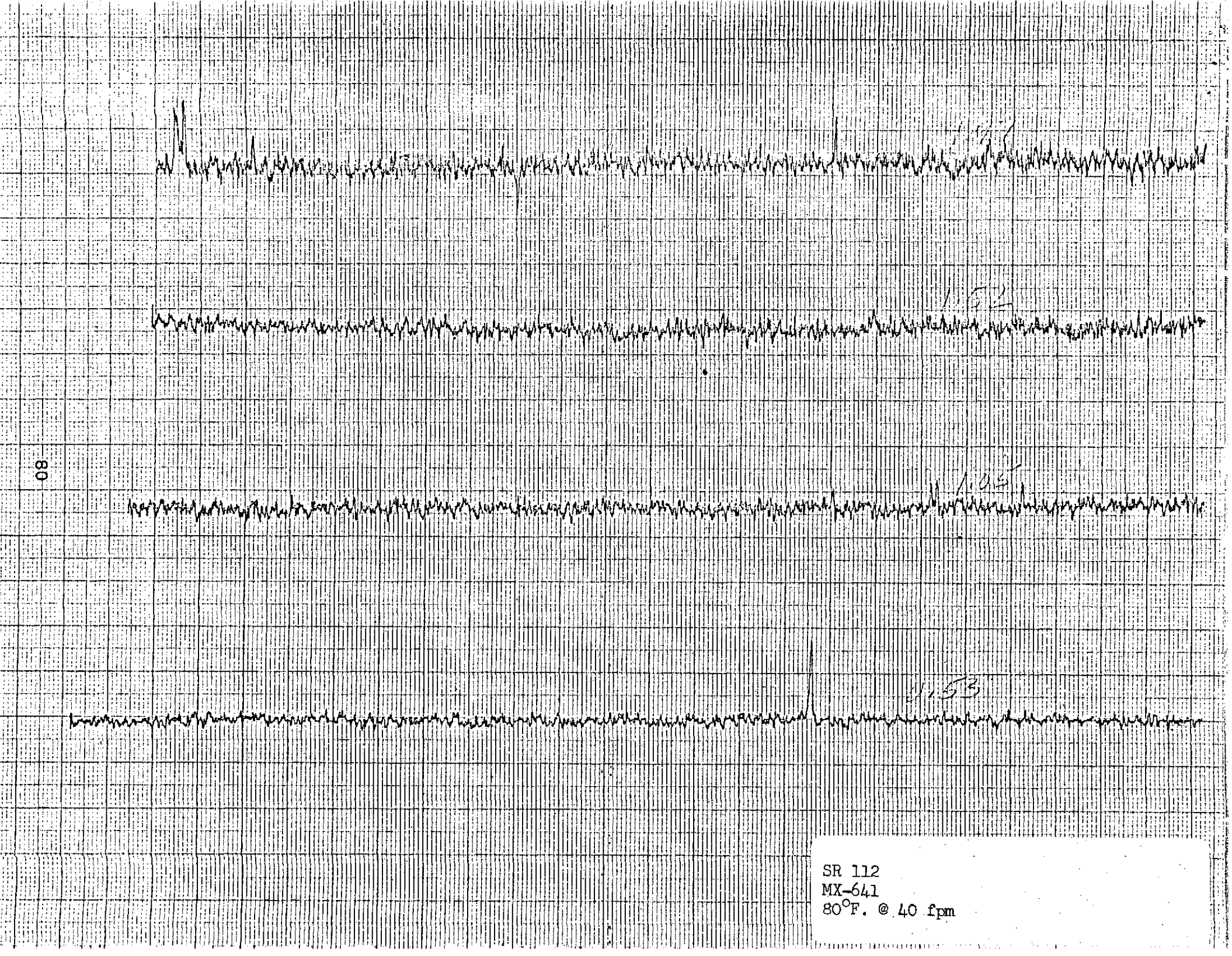

SR 112
MX-641
68°F @ 20 fpm

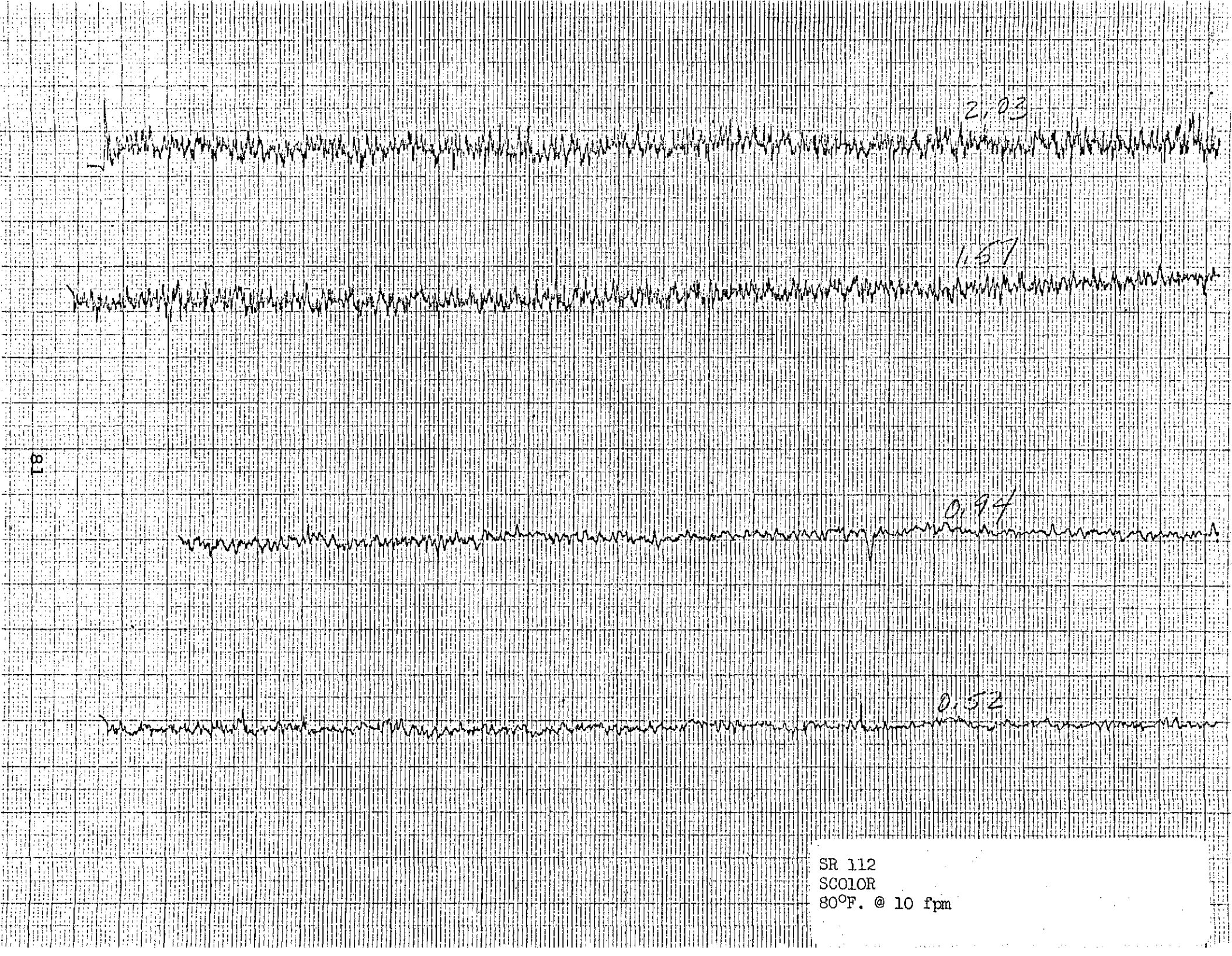


SR 112
MX-641
68°F. @ 40 fpm


78
SR 112
MX-641
80°F. @ 10 fpm

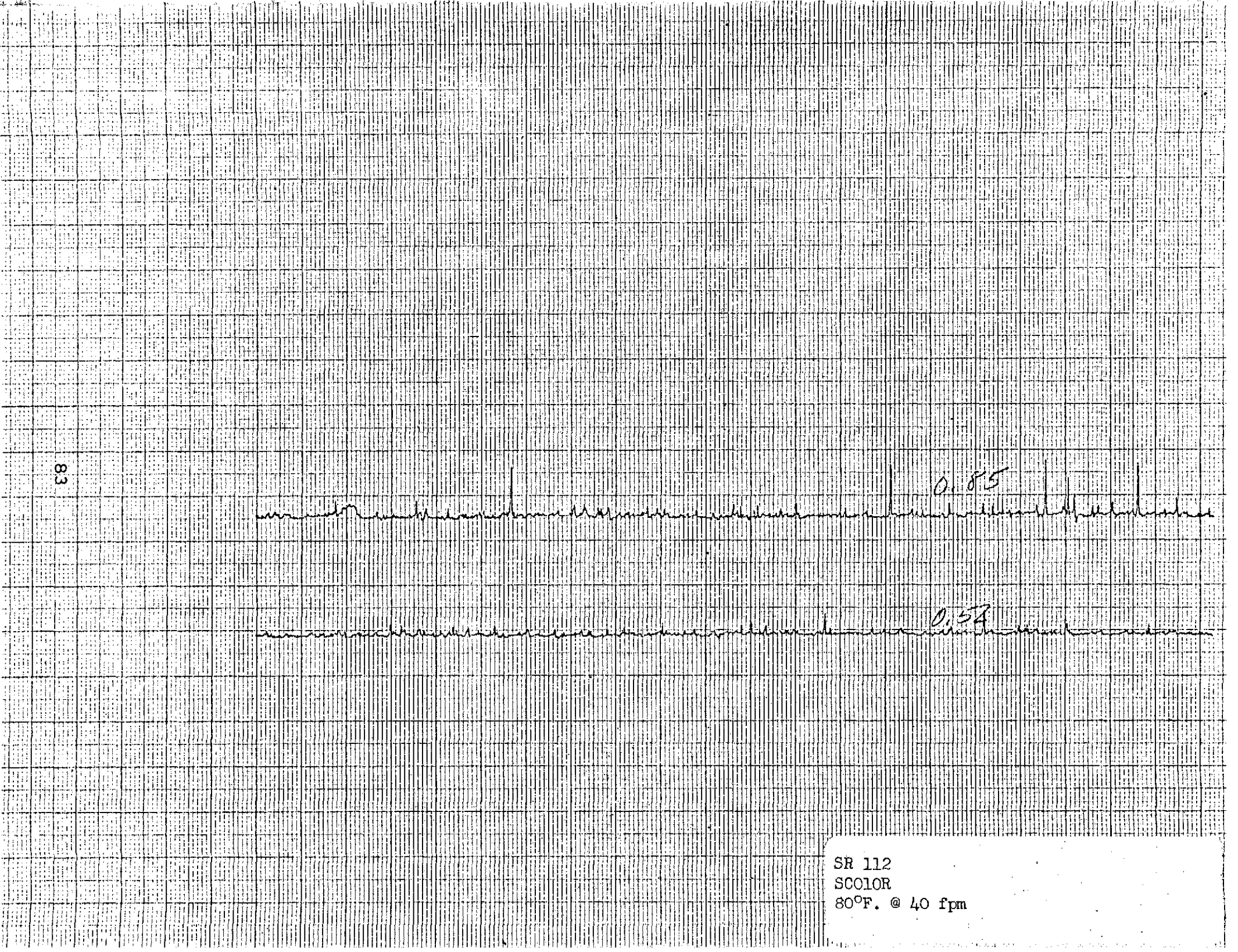

79
SR 112
MX-641
80°F. @ 20 fpm

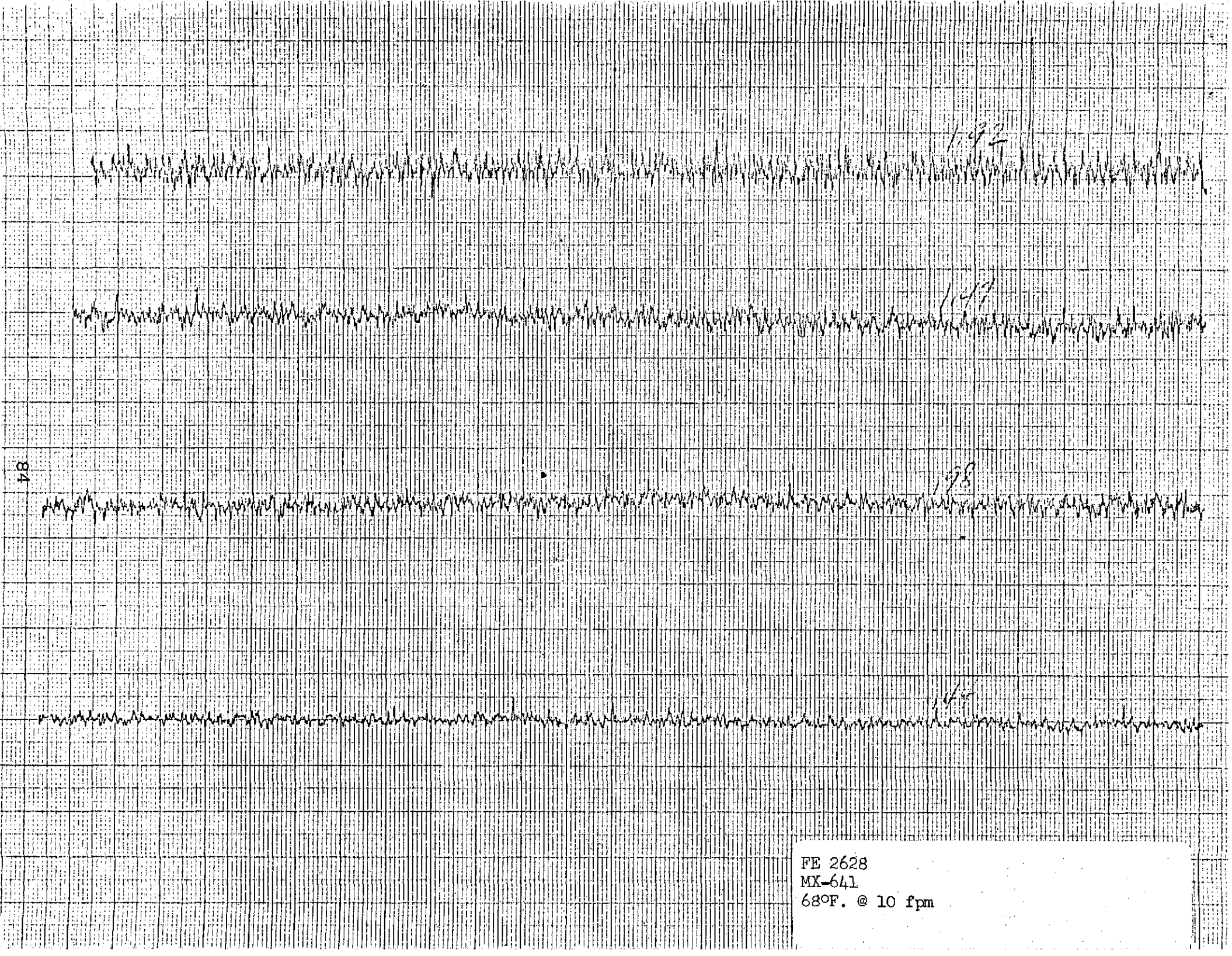

80
SR 112
MX-641
80°F. @ 40 fpm

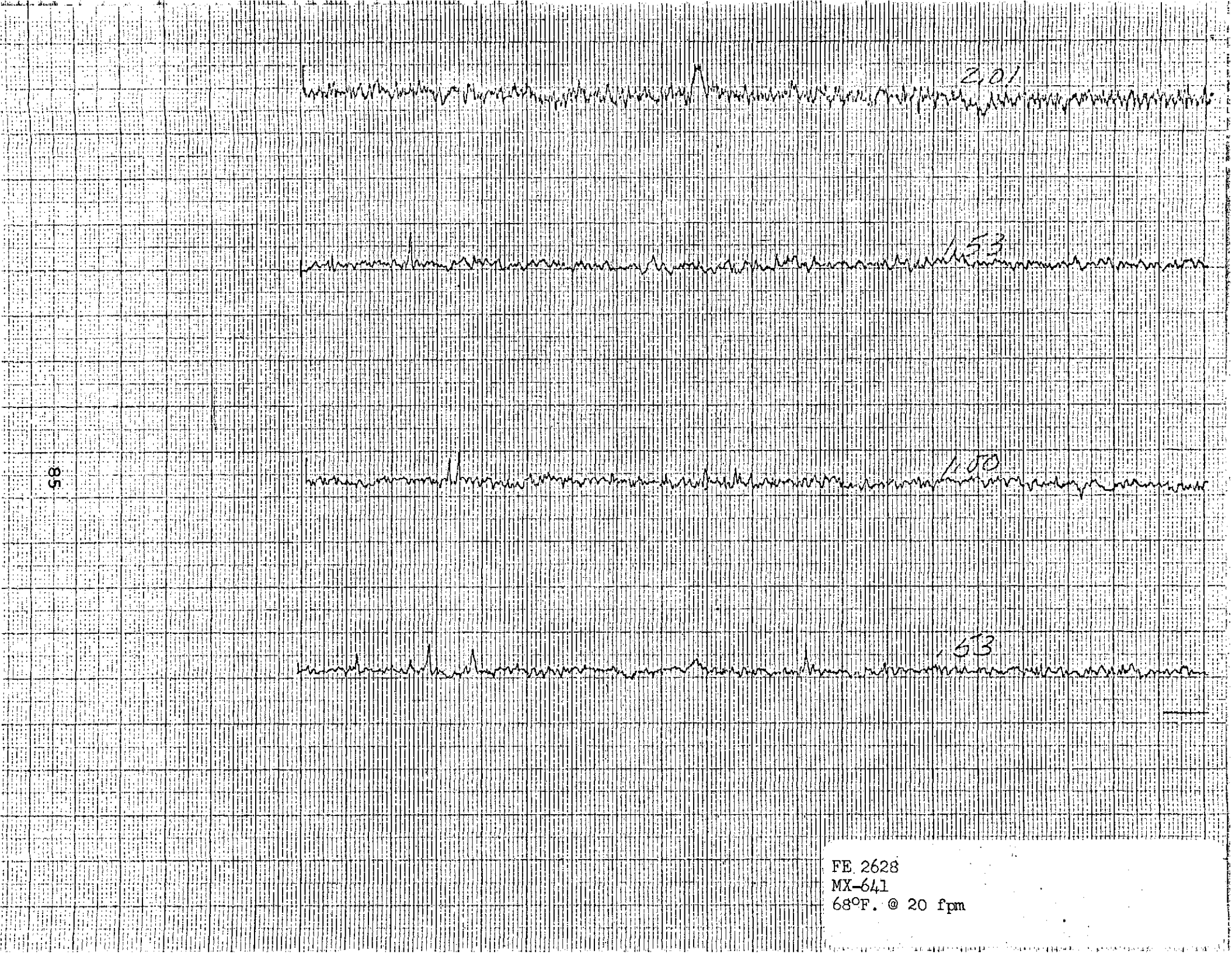


SR 112
SCOLOR
80°F. @ 10 fpm


SR 112
SCOLOR
80°F. @ 20 fpm

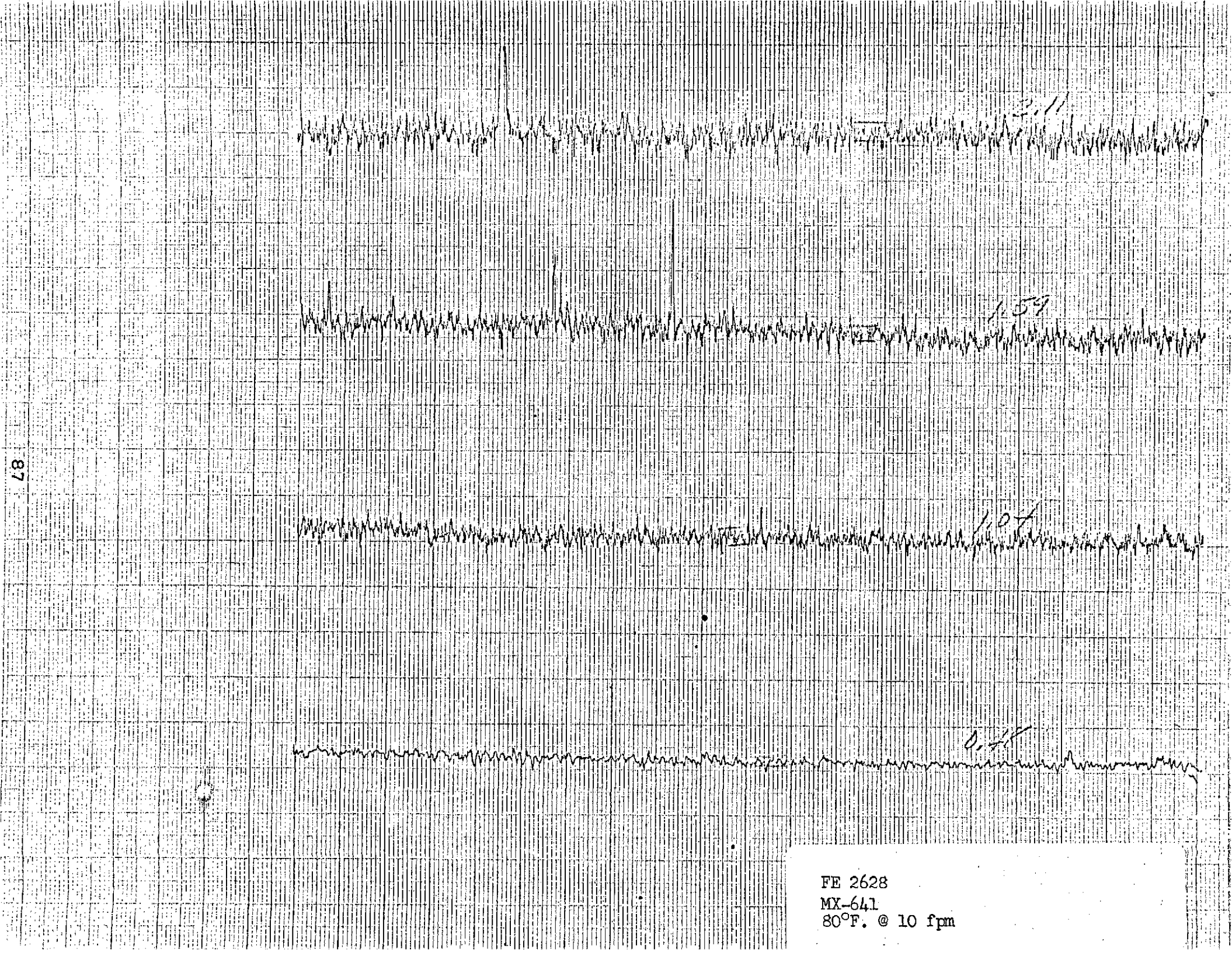

83
0.85
0.54
SR 112
SCOLOR
80°F. @ 40 fpm


84
FE 2628
MX-641
68°F. @ 10 fpm

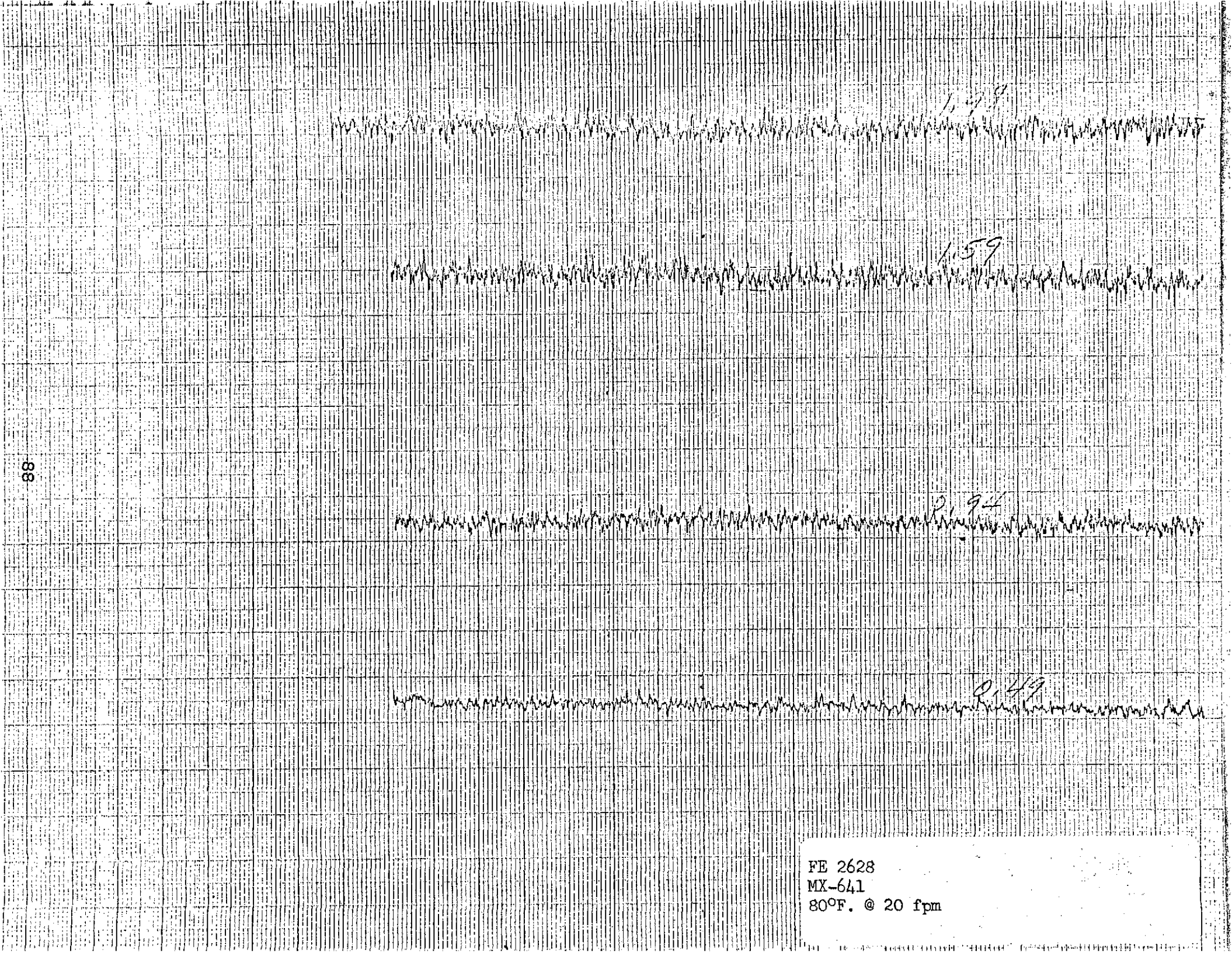


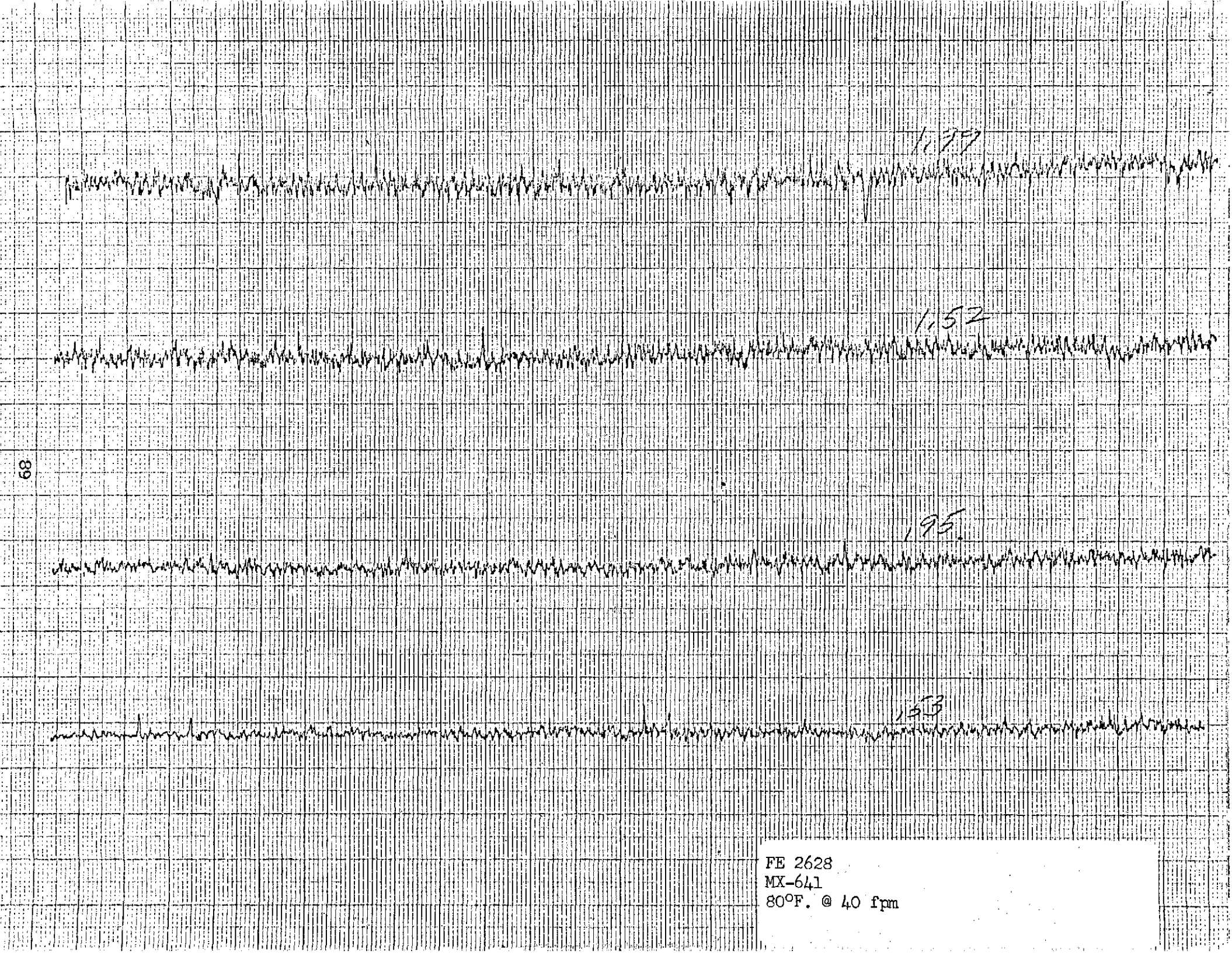
FE 2628
MX-641
68°F. @ 20 fpm

FE 2628
MX-641
68°F. @ 40 fpm

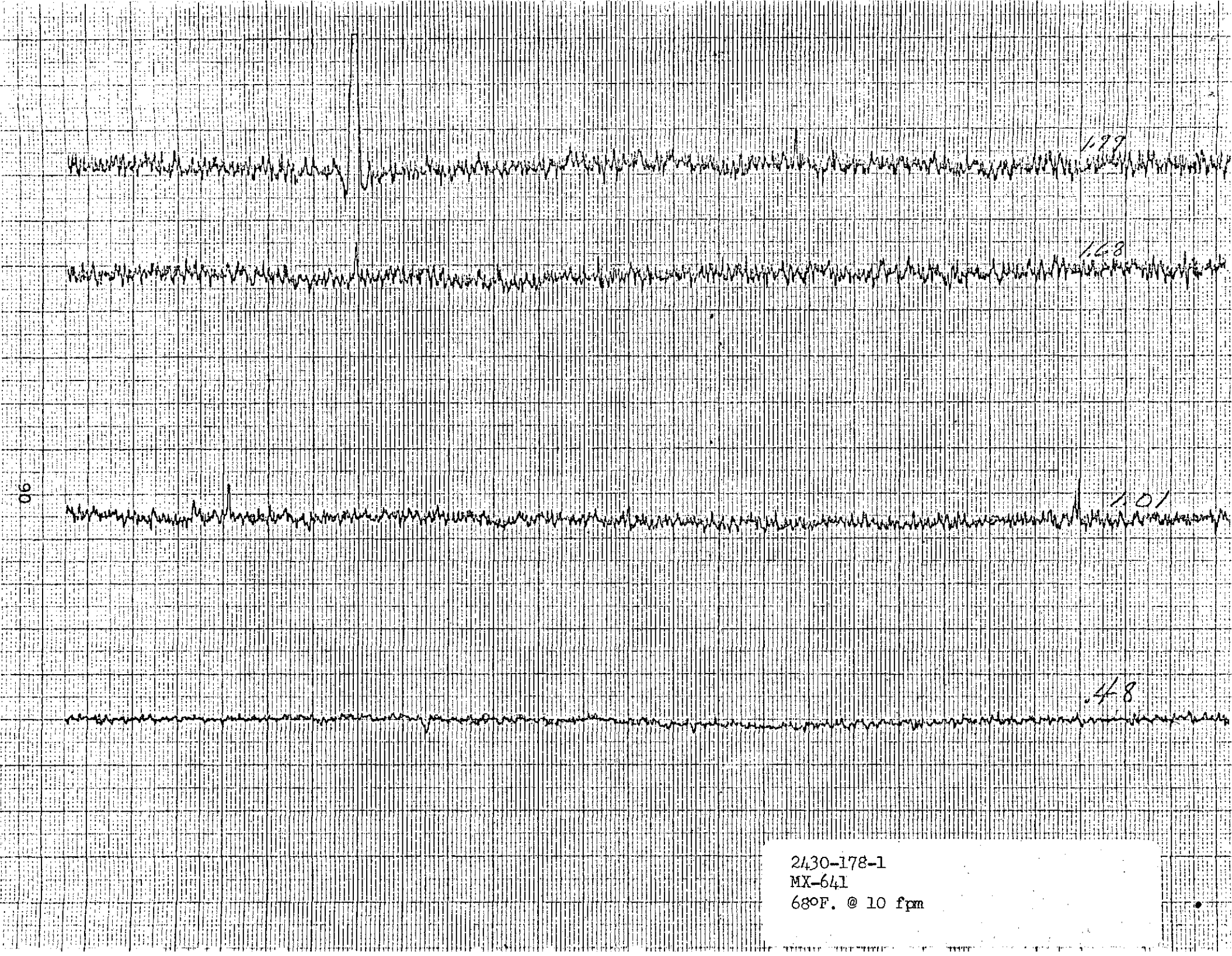


FE 2628
MX-641
80°F. @ 10 fpm

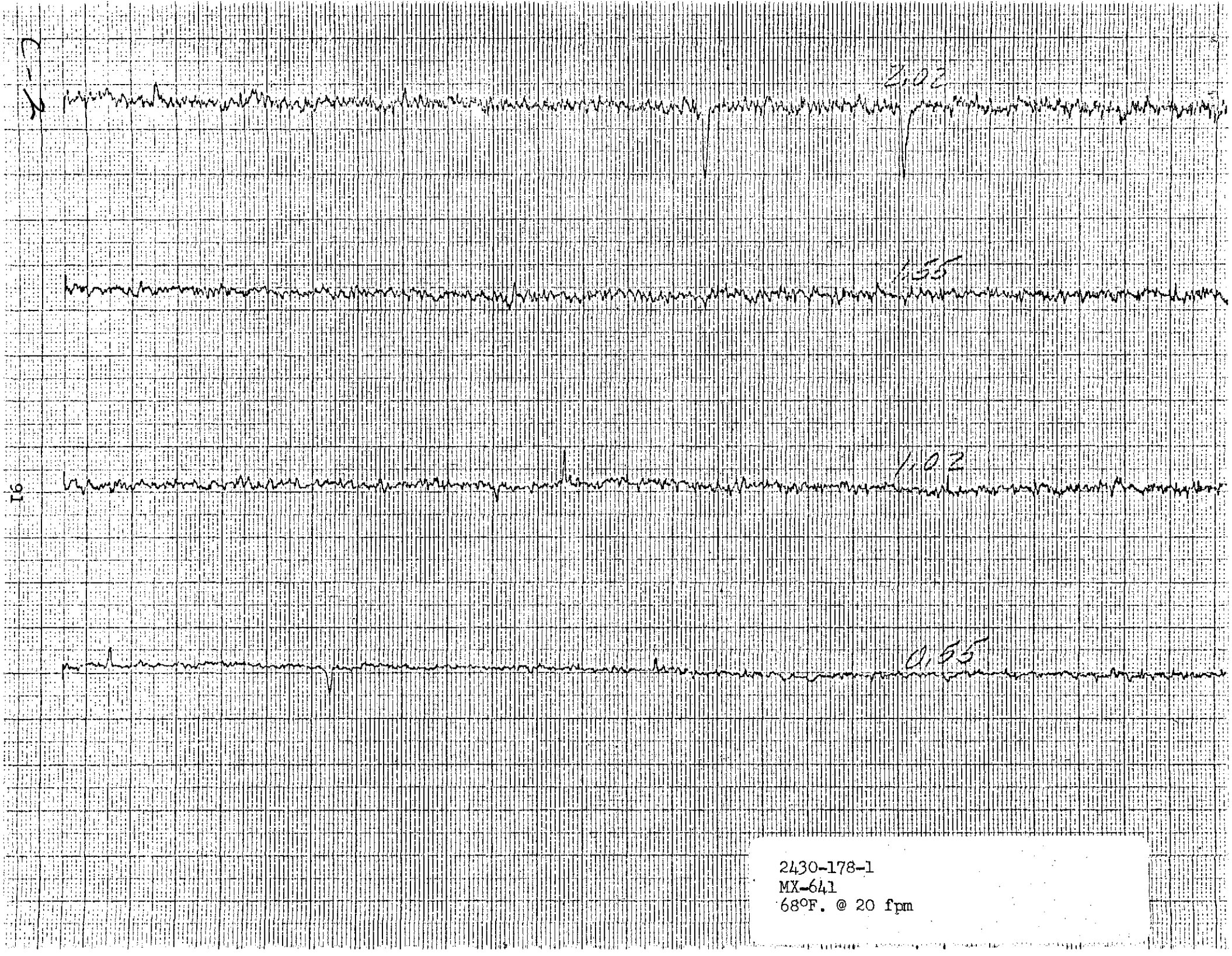

1:54
1:59
2:04
2:09
FE 2628
MX-641
80°F. @ 20 fpm



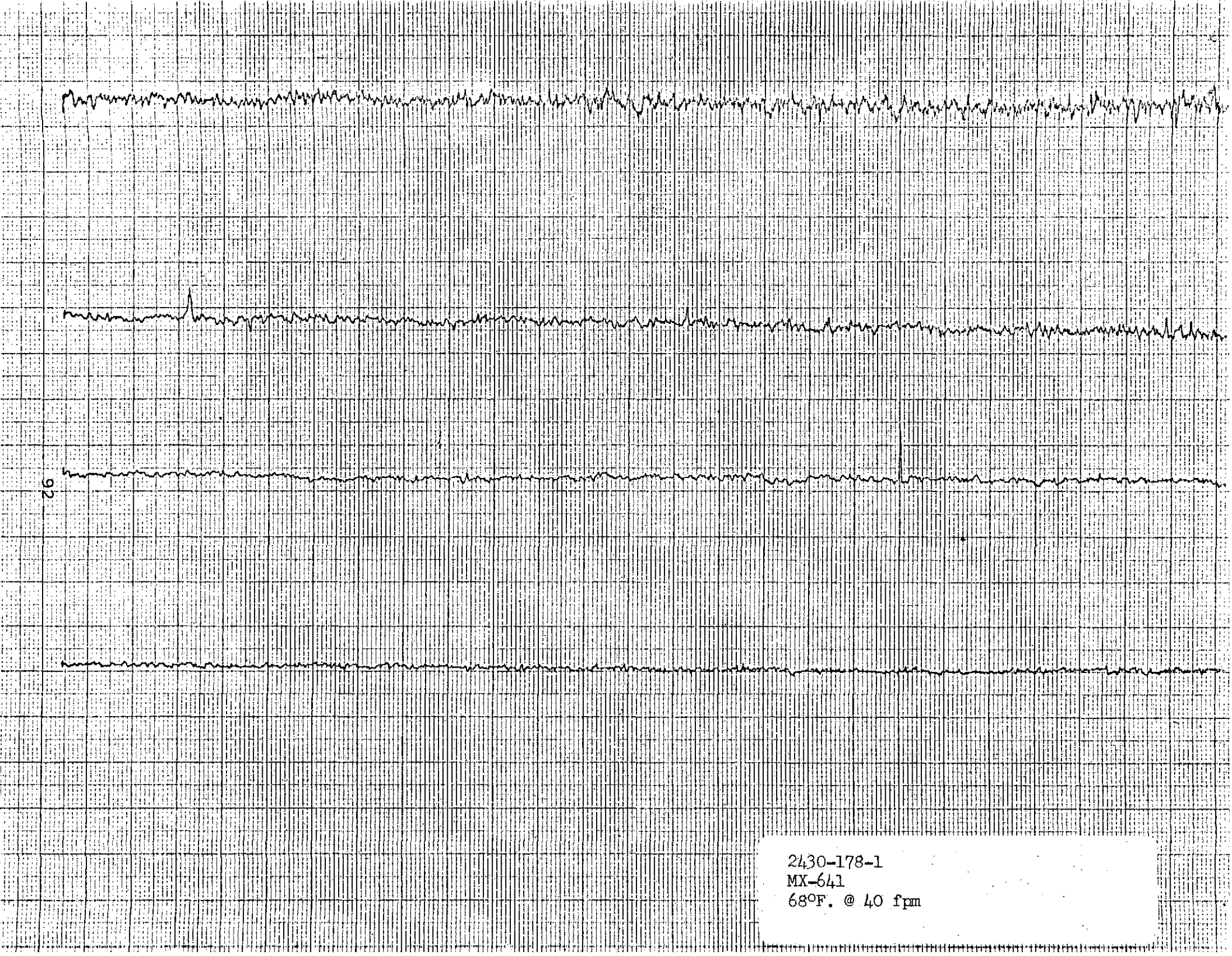
FE 2628
MX-641
80°F. @ 40 fpm



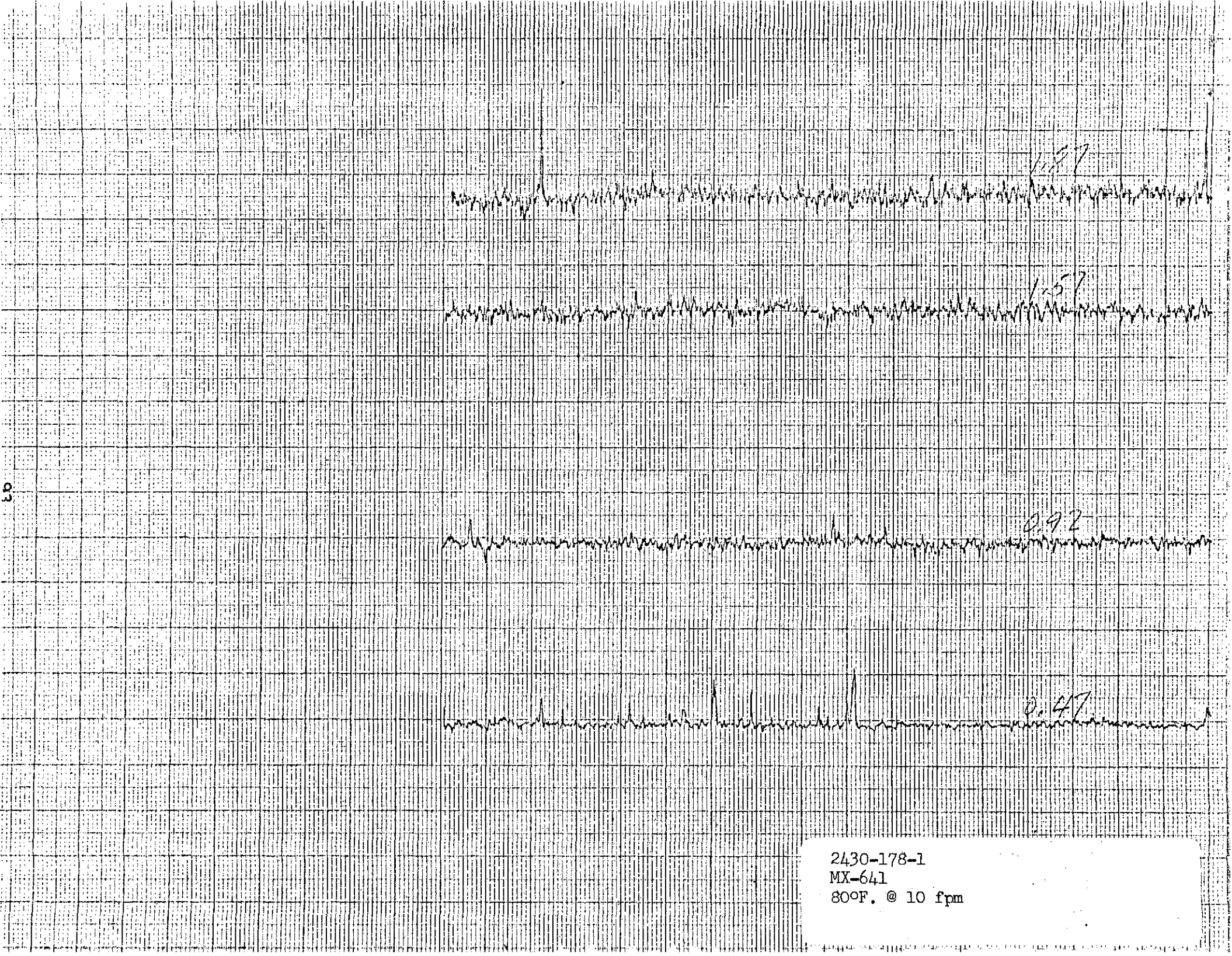
2430-178-1
MX-641
68°F. @ 10 fpm



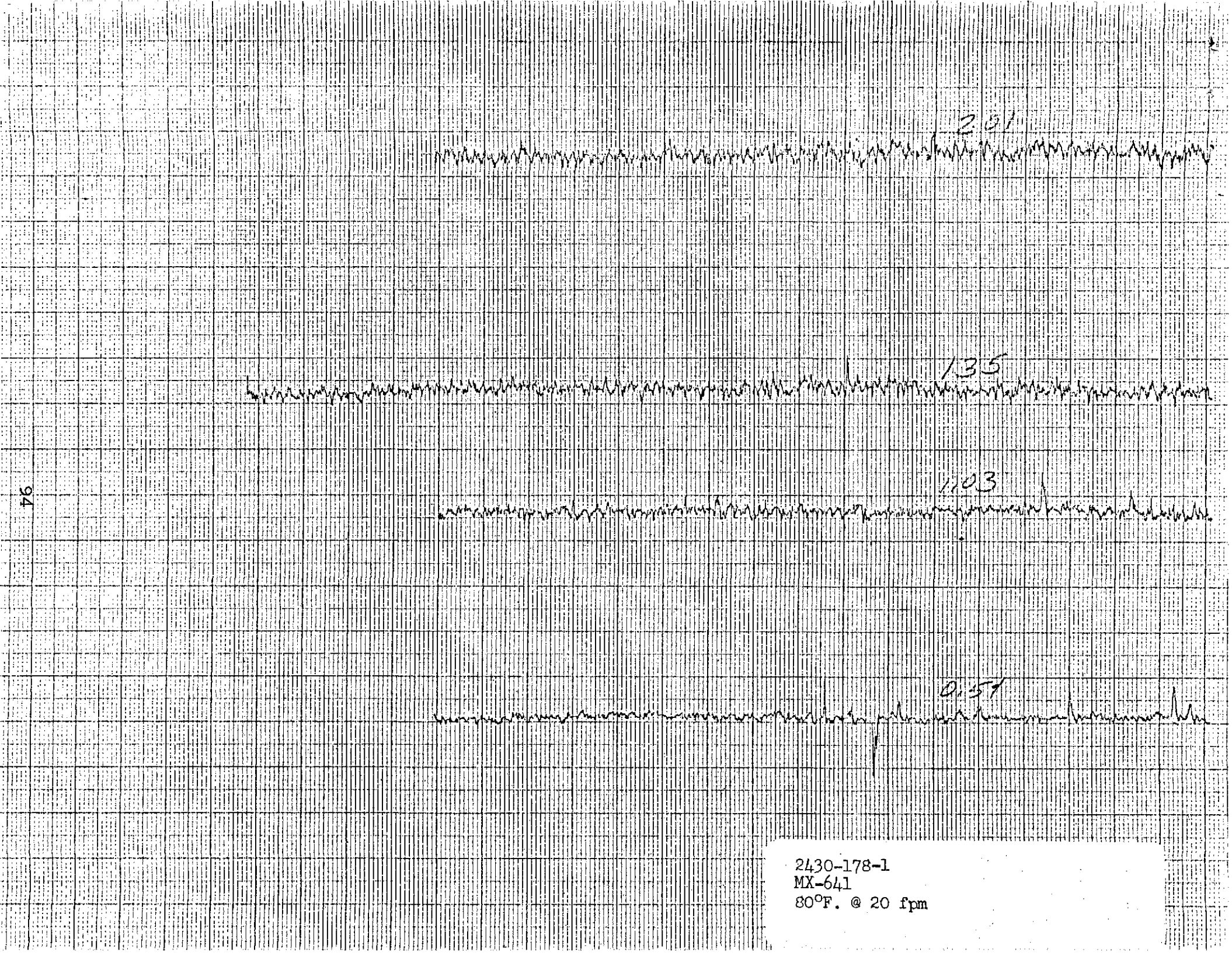
2430-178-1
MX-641
68°F. @ 20 fpm

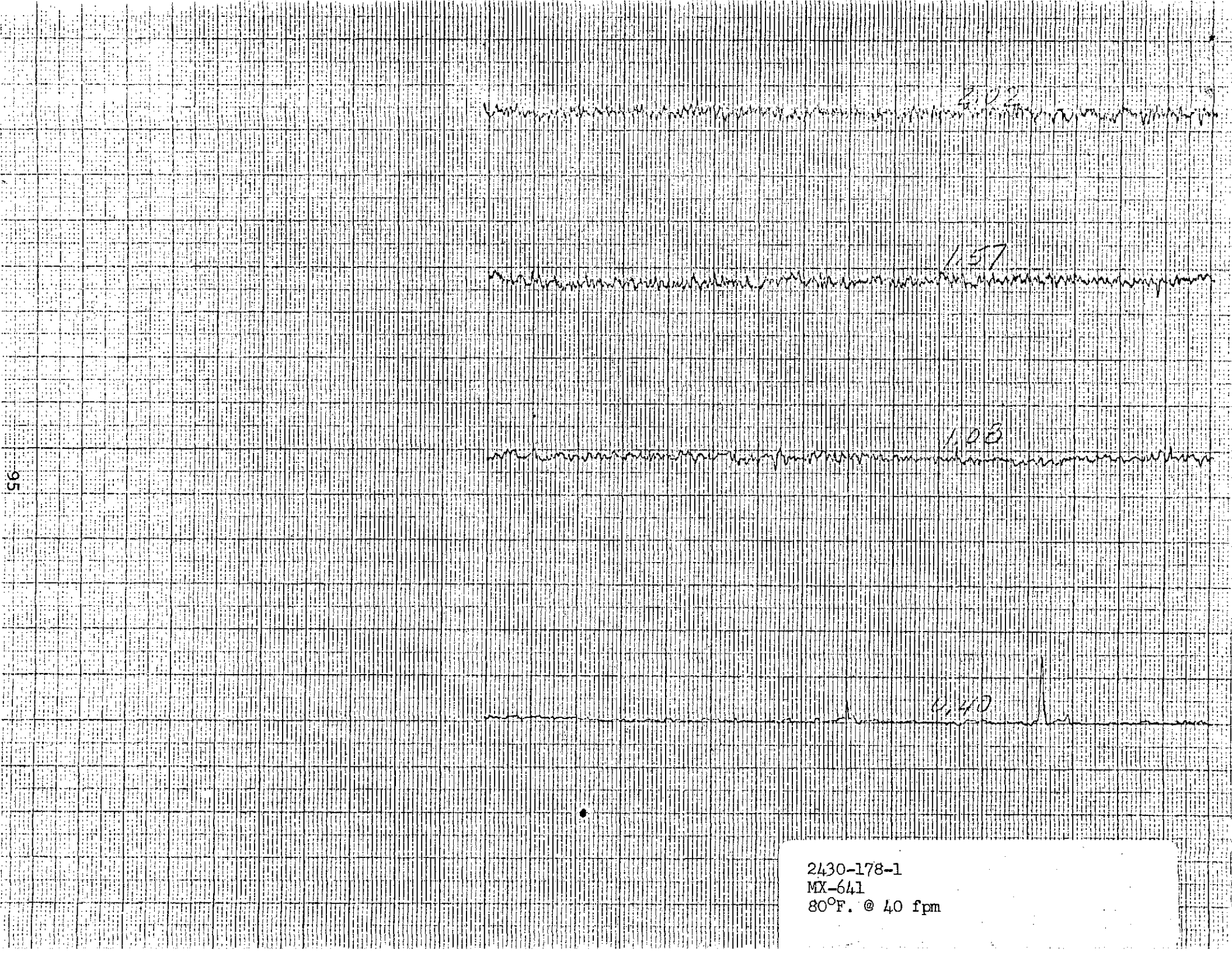


2430-178-1
MX-641
68°F. @ 40 fpm



2430-178-1
MX-641
80°F. @ 10 fpm


2.51
1.35
1.03
0.57
94
2430-178-1
MX-641
80°F. @ 20 fpm



95

2430-178-1
MX-641
80°F. @ 40 fpm